SOIL SURVEY OF
Jeff Davis County, Texas

ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated May 1977. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1965-70. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Big Bend, Highland, High Point, and Toyah-Limpia Soil and Water Conservation Districts.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

This soil survey contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Jeff Davis County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" (Removed) can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and shows the capability classification of each. It also shows the page where each soil is described and the range site in which the soil has been placed.

Individual colored maps that show the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the capability units and the range sites.

Foresters and others can refer to the section "Use of the Soils for Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils as Wildlife Habitat."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range and, also, the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the sections "Engineering Uses of the Soils" and "Use of the Soils for Recreation."

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Jeff Davis County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county at the beginning of the publication and in the section "Additional Facts About the County."

Cover: Davis Mountains at about 5,000 feet elevation. The soils formed mostly in igneous material. In the foreground are gently sloping soils of the Santo Tomas-Medley association. In the background are hilly soils of the Mainstay-Brewster association.

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SOIL SURVEY OF JEFF DAVIS COUNTY, TEXAS

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

Jeff Davis County is in the Trans-Pecos region of far southwest Texas (fig. 1). The county is 2,259 square miles, or 1,445,760 acres. It has the highest average elevation of any county in Texas. Mount Livermore, 8,382 feet, is the second highest mountain in the State. The sparse rural population depends on ranching and tourist trade.

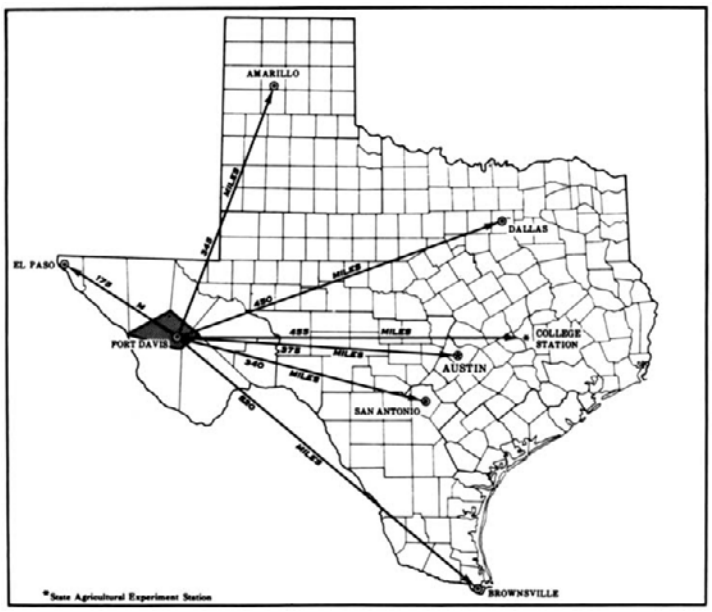

Figure 1.—Location of Jeff Davis County in Texas.

Farm enterprise is mainly beef cattle production and some sheep and goats. On a few small irrigated areas in Limpia Canyon, forage, fruits, and vegetables are grown. On a small part of the Lobo irrigated farm area, cotton and grains are mostly grown.

The major tourist attractions of the county are Old Fort Davis National Historical Site, McDonald Observatory on Mount Locke, Davis Mountain State Park and Indian Lodge, the 74-mile scenic-loop highway around the higher parts of the Davis Mountains, and various guest ranches, Antelope and mule deer are major attractions for sportsmen during the hunting season. The scenic beauty and invigorating climate also attract tourists, especially during summer.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Jeff Davis County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds

of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Brewster and Musquiz, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Verhalen clay, depressional, is one of several phases within the Verhalen series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Jeff Davis County: soil associations and undifferentiated groups.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Boracho-Espy association, gently sloping, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils or of two or more. Anthony and Glendale soils is an undifferentiated soil group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Badland and Gullied land are land types in this county.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for the irrigated soils in this survey.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Jeff Davis County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map that shows soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into two general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages.

Soils of Hills and Mountains

This group consists mainly of shallow, hilly to steep soils of hills and mountains. These soils are used mainly for range. They are too shallow or too steep for crops or pasture. Other important uses are wildlife habitat and recreation.

1. Brewster association

Shallow to very shallow, hilly to steep, noncalcareous soils of arid and semiarid hills

The soils of this association are on hills of the lower part of the Davis Mountains where elevation is mainly 4,500 to 5,000 feet. Vegetation is a moderate cover of mainly grass. The annual rainfall of about 15 inches is enough to enable the soils to

maintain a cover of grass but only a few widely scattered low shrubs or trees. The dominant grasses are blue grama and side-oats grama, and the main woody plant is catclaw. Available water capacity is low in these soils.

This association makes up about 23 percent of the county. It is about 58 percent Brewster soils. The remaining 42 percent is Kokernot soils on divides of hills; Liv, Mainstay, and Volco soils on hilly to steep parts of hills ; and the land type Rock outcrop along steep breaks and scarps of hills.

Brewster soils are hilly to steep and are on the sides of hills. They are reddish-brown, neutral gravelly loam that is about 7 inches thick over fractured rhyolite bedrock.

The soils of this association are used only for range. They are too stony and too shallow for irrigated crops or pasture. The hazard of water erosion is severe unless the surface is protected by a cover of grass.

2. Mainstay-Liv-Brewster association

Very shallow to moderately deep, hilly to steep, noncalcareous soils of semiarid hills and mountains

The soils of this association are on steep Davis Mountains where elevation is mainly 4,500 to 6,250 feet. Vegetation is grasses and low trees. The annual rainfall of 14 to 20 inches is enough to enable the soils to maintain a cover of mid and short grass and some trees and low shrubs. Available water capacity is low to moderate in these soils. Igneous rock fragments make up about 50 percent, by volume, of the material in the major soils.

This association makes up about 21 percent of the county. It is about 26 percent Mainstay soils, 25 percent Liv soils, and 21 percent Brewster soils. The remaining 28 percent is Sproul soils on gently sloping divides, Rockhouse soils, along narrow drainageways, and the land type Rock outcrop along sharp breaks and scarps.

Mainstay soils are on the side and basal slopes of mountains. They have a surface layer of very dark grayish-brown, neutral cobbly silt loam about 3 inches thick. The next layer is very dark grayish-brown gravelly clay about 3 inches thick. This is underlain by reddish-brown, firm, slightly acid gravelly clay about 10 inches thick. Depth to igneous bedrock is about 16 inches.

Liv soils are on the side and basal slopes of mountains. They have a surface layer of very dark grayish-brown, neutral cobbly silt loam about 9 inches thick. The next layer is very dark grayish-brown gravelly clay about 8 inches thick. This is underlain by about 6 inches of dark reddish-gray gravelly clay and by reddish-brown gravelly clay that extends to a depth of 38 inches. The underlying material is tuffaceous rock.

Brewster soils are near the top of mountains. The soil material is reddish-brown, friable, neutral gravelly loam. It is underlain, at a depth of about 7 inches, by hard, fractured rhyolite bedrock.

The soils of this association are used only for range. They are too stony and too steep for crops or pasture. The hazard of water erosion is severe unless the surface is protected by a cover of grass.

3. Volco-Brewster-Ector association

Shallow to very shallow, hilly to steep, calcareous to noncalcareous soils of arid and semiarid hills

The soils of this association are on hills in the arid to semiarid part of the county where elevation is mainly 3,500 to 5,000 feet. Vegetation is a thin cover of grasses and shrubs. The annual rainfall of 7 to 15 inches is not enough to enable the soils to maintain a continuous cover of plants. The space between plants is generally only a

few inches, depending on soil moisture. Available water capacity is low on these soils.

This association makes up about 6 percent of the county. It is about 34 percent Volco soils, 31 percent Brewster soils, and 15 percent Ector soils. The remaining 20 percent is Lozier soils and the land type Rock outcrop.

Volco soils have a surface layer of grayish-brown, calcareous gravelly loam that is 40 percent, by volume, igneous and caliche rock fragments. It is about 4 inches thick. The next layer is brown, friable, calcareous gravelly loam that is 55 percent, by volume, lime-coated igneous rock fragments. It is about 5 inches thick. The underlying material is igneous bedrock.

Brewster soils are about 50 percent, by volume, igneous rock fragments. These soils are reddish-brown, friable, neutral gravelly loam about 7 inches thick over hard, fractured rhyolite bedrock.

Ector soils are about 8 inches deep over lime-coated limestone bedrock. They are grayish-brown, friable, calcareous gravelly loam that is about 55 percent, by volume, limestone and caliche fragments.

The soils of this association are used mainly for range. They are too stony and too shallow for pasture or irrigated crops. The hazard of water erosion is high unless the surface is protected by a cover of grass.

4. Puerta-Rock outcrop-Madrone association

Shallow to moderately deep, steep, noncalcareous soils and rock outcrop of semiarid and subhumid hills and mountains

The soils of this association are on steep Davis Mountains where elevation is mainly 5,000 to 7,500 feet or more. Vegetation is trees and grasses. The annual rainfall is 16 to 26 inches.

This association makes up about 3 percent of the county. It is about 22 percent Puerta soils, 22 percent Rock outcrop, and 17 percent Madrone soils. The remaining 39 percent is Loghouse, Brewster, Liv, and Mainstay soils in narrow valleys and canyons and on the south-facing sides of mountains.

Puerta soils have north-facing slopes. They have a surface layer of dark grayish-brown, neutral gravelly silt loam about 5 inches thick. The next layer is light brownish-gray, friable, medium acid gravelly loam about 4 inches thick. This is underlain by brown, firm, strongly acid gravelly clay about 9 inches thick. Depth to fractured igneous bedrock is about 18 inches.

Rock outcrop consists of breaks, hills, steep peaks, scarps, canyon walls, and bluffs that are mainly rock surfaces.

Madrone soils have north-facing slopes. They have a surface layer of dark grayish-brown, neutral cobbly silt loam about 5 inches thick. The next layer is pale-brown, very friable, strongly acid cobbly loam about 4 inches thick. This is underlain by brown, very strongly acid cobbly clay about 27 inches thick. Depth to fractured igneous bedrock is about 36 inches.

The soils of this association are used mainly for range. They are too steep and too stony for pasture or crops. Areas of the association on protected slopes are suitable for woodland.

Soils of Valleys, Plains, and Basins

This group consists mainly of deep, nearly level to hilly soils of valleys, plains, and basins. These soils are used mainly for range. Most soils of this group, however, are also suitable for irrigated crops and pasture.

5. Musquiz-Santo Tomas-Boracho association

Very shallow to deep, nearly level to gently sloping, noncalcareous and calcareous soils of arid and semiarid valleys

The soils of this association are in intermountain valleys. Vegetation is a moderate cover of mainly grass. The annual rainfall of about 15 inches is enough to enable the soils to maintain a cover of mid and short grass and a few widely scattered low shrubs and trees.

This association makes up about 20 percent of the county. It is about 20 percent Musquiz soils, 18 percent Santo Tomas soils, and 13 percent Boracho soils. The remaining 49 percent is Medley soils on fans between hills; Espy, Limpia, and Mitre soils on old high terraces and fans next to mountains; and Verhalen soils on nearly level flats.

Musquiz soils are on plains. They have a surface layer of reddish-gray, mildly alkaline loam about 7 inches thick. The next layer is reddish-brown clay 10 inches thick. This is underlain by red, firm, neutral clay about 13 inches thick. The next layer is light reddish-brown clay loam about 10 inches thick. The underlying material to a depth of 60 inches is light reddish-brown loam.

Santo Tomas soils are on fans between hills and the Musquiz soils. They have a surface layer of reddish-brown, neutral very gravelly loam about 24 inches thick that is about 50 percent, by volume, igneous pebbles. The next layer is brown, friable, calcareous very gravelly loam about 36 inches thick. The underlying material is brown, massive, calcareous gravelly loam.

Boracho soils are on old high terraces and fans next to mountains. They have a surface layer of grayish-brown, calcareous gravelly loam about 10 inches thick that is about 45 percent, by volume, igneous and caliche rock fragments. This is underlain by a pinkish-white caliche layer that is indurated in the upper part and cemented below.

The soils of this association are used mainly for range. Most of the soils are suitable for irrigated crops, but only a few small areas are irrigated. Most of these soils have a slight to moderate hazard of water erosion.

6. Redona-Verhalen-Reagan association

Deep, nearly level to gently sloping, calcareous to noncalcareous soils of arid and semiarid valleys and plains

The soils of this association are in arid and semiarid valleys and on plains. Vegetation is a thin cover of grasses and shrubs. The annual rainfall of 7 to 14 inches is not enough to enable the soils to maintain a continuous cover of plants. The space between plants is generally only a few inches, depending on soil moisture.

This association makes up about 19 percent of the county. It is about 20 percent Redona soils, 11 percent Verhalen soils, and 10 percent Reagan soils. The remaining 59 percent is Chispa, Nickel, Sanderson, Upton, and Vado soils on undulating fans and ridges; Hodgins soils on nearly level to gently sloping plains; and Dalby and Phantom soils on flats and in drainageways.

Redona soils are on nearly level to gently sloping plains. They have a surface layer of reddish-brown, neutral sandy loam about 6 inches thick. The next layer is reddish-brown, friable, mildly alkaline sandy clay loam about 16 inches thick. Beneath this layer is light-brown, friable, calcareous clay loam about 24 inches thick. The underlying material to a depth of 80 inches is light brown. It is loam in the upper part and very gravelly sand in the lower part.

Verhalen soils are on flats and in drainageways. They have a surface layer of grayish-brown, calcareous clay about 4 inches thick. The next layer is brown, very firm, calcareous clay about 26 inches thick that has many slickensides on ped

surfaces. Below this layer is light-brown clay about 18 inches thick. The next layer is light reddish-brown, calcareous clay about 12 inches thick. This is underlain by light-brown, friable, calcareous clay loam that extends to a depth of 75 inches or more.

Reagan soils are on nearly level to gently sloping plains. They have a surface layer of light brownish-gray clay loam about 4 inches thick. The next layer is pinkish-gray clay loam about 6 inches thick. Below this layer is pale-brown, friable, calcareous clay loam about 16 inches thick. The next layer is pink calcareous clay loam about 16 inches thick. This is underlain to a depth of 70 inches or more by light-brown clay loam.

The soils of this association are used mainly for range. Most of the soils are suitable for irrigated crops (fig. 2), but only a few small areas are irrigated.

Figure 2.—Landscape and vegetation of Redona-Verhalen-Reagan association. The deep, nearly level Redona soils are well suited to irrigated crops.

7. Nickel-Canutio-Vieja association

Very shallow to deep, undulating to hilly, calcareous soils of arid basins

The soils of this association are in the desert zone. Vegetation is a sparse cover of grasses and shrubs. The annual rainfall of 6 to 10 inches is not enough to enable the soils to maintain a sufficient cover of plants. There is a distinct space of several feet between plants.

This association makes up about 4 percent of the county. It is about 27 percent Nickel soils, 15 percent Canutio soils, and 13 percent Vieja soils. The remaining 45 percent is Anthony and Glendale soils on flood plains; Chispa, Vado, and Sanderson soils on ridges and fans; Hodgins and Redona soils in valleys and on plains; Lozier and Volco soils on hills; and Badland on eroded scarps of volcanic ash.

Nickel soils are on fans. They have a surface layer of pale-brown gravelly loam about 7 inches thick that is about 40 percent, by volume, caliche-coated pebbles. This layer is underlain by white, weakly cemented, fragmental gravelly caliche.

Canutio soils are also on fans. They have a surface layer of pale-brown, calcareous gravelly loam about 8 inches thick. The next layer is very pale brown, loose, calcareous very gravelly loam about 22 inches thick. This is underlain by very gravelly loam about 30 inches thick.

Vieja soils are on hills. They are about 8 inches deep over clayey shale and have a surface covered with a mantle of coarse fragments. The soil is pale-brown, firm, calcareous silty clay.

The soils of this association are used mainly for range and as wildlife habitat.

8. Gageby-Rockhouse association

Deep, nearly level, noncalcareous soils of flood plains

The soils of this association are on flood plains of the larger streams that drain hills and mountains.

This association makes up about 4 percent of the county. It is about 50 percent Gageby soils and 40 percent Rockhouse soils (fig. 3). The remaining 10 percent is Santo Tomas and Medley soils on terraces of flood plains.

Gageby soils have a surface layer of dark grayish-brown silt loam about 15 inches thick. The next layer is dark grayish-brown clay loam about 33 inches thick. Below this is grayish-brown clay loam about 10 inches thick. The underlying material to a depth of 68 inches is brown loam.

Rockhouse soils have a surface layer of dark grayish-brown loam about 12 inches thick. The next layer to a depth of 60 inches is grayish brown. It is very cobbly loamy sand in the upper part and very cobbly sand in the lower part.

The soils in this association are used mainly for native range. They are well suited to irrigated crops and pasture. Some of the soils are used for irrigated crops and orchards.

Figure 3.—Beehives on Gageby-Rockhouse association. The bees gather from the catclaw and whitebrush that grow on the Gageby and Rockhouse soils.

Descriptions of the Soils

This section describes the soil series and mapping units in Jeff Davis County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to

get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative of mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

Almost all the mapping units in this survey are broadly defined. Management suggestions for growing crops are not given for these units. Management suggestions are given for several more narrowly defined mapping units that are used for irrigated crops.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badland and Gullied land, for example, do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and range site in which the mapping unit has been placed. All of the capability units in Jeff Davis County are dryland units except units I-1 and IIs-1, which are irrigated units. The irrigated ones are so indicated by the word "irrigated" in parentheses after the symbol. The page for the description of each capability unit and range site can be learned by referring to the "Guide to Mapping Units, (Removed)" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual *(10).*

Anthony Series

The Anthony series consists of deep, well-drained, calcareous loamy soils. These soils formed in stratified alluvium. They are on flood plains and low terraces of streams in the Rio Grande Basin. The native vegetation is a thin cover of short grasses and desert shrubs.

In a representative profile the surface layer is pale-brown, calcareous fine sandy loam about 15 inches thick. The underlying layer is grayish-brown, friable, calcareous fine sandy loam about 45 inches thick that has a few thin layers of loamy sand and sandy loam. Below this is very pale brown, calcareous gravelly sand 5 inches thick or more.

Permeability is moderately rapid in these soils. Runoff is slow to medium. The soils are occasionally flooded in summer.

Anthony soils are used mainly for range. They are well suited to pasture and irrigated crops.

Representative profile of Anthony fine sandy loam in an area of Anthony and Glendale soils, about 28 miles west of Valentine, 18 miles northwest of Valentine on U.S. Highway 90 to the junction of Farm Road 2017, 3.5 miles west on Farm Road 2017 to junction with county road, 18 miles southwest on county road to a house near the Rio Grande, and 100 yards north of house:

A1—0 to 15 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; few

roots and pebbles; calcareous; moderately alkaline; clear, smooth boundary.

C1—15 to 60 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; few pebbles; few thin strata of loamy sand and sandy loam; calcareous; moderately alkaline; abrupt, smooth boundary.

C2—60 to 65 inches, very pale brown (10YR 7/3) gravelly sand, pale brown (10YR 6/3) moist; single grained; 25 percent, by volume, subrounded pebbles; calcareous; moderately alkaline.

Depth to contrasting layers is more than 40 inches. The soil is 0 to 15 percent, by volume, coarse fragments. The material between depths of 10 and 40 inches is 5 to 18 percent clay. Threads and films of lime or other salts are common in places.

The A horizon ranges from 6 to 20 inches in thickness. It is pale-brown, light-brown, grayish-brown, light brownish-gray, or brown loam or fine sandy loam. The C1 horizon is pale-brown, light-brown, grayish-brown, light brownish-gray, very pale brown, or brown loam or fine sandy loam that has thin strata of sand or sandy loam. The C2 horizon is gravelly sand, fine sand, and sandy loam in some places.

Anthony and Glendale soils (Ag).—This mapping unit is on flood plains. Slopes are mostly less than 1 percent. Areas are long and narrow and follow intermittent streams. They are 720 to 3,360 acres in size.

This mapping unit is 30 to 70 percent Anthony loam and fine sandy loam, 0 to 50 percent Glendale loam and clay loam, 5 to 10 percent gravelly and stony stream-washed material, and 10 to 30 percent other soils. Patterns of soil distribution within the mapped areas are not uniform and occur without regularity. Areas of this mapping unit are long and narrow along draws and intermittent streams. The soil surface is mostly crusted, and in places small dunes as much as 2 feet high have accumulated around mesquite clumps. Bench scarps and banks are between various levels of channels, bottoms, and terraces.

Included with these soils in mapping are areas of Vieja and Lozier soils that are shallow to shale or limestone and areas of Canutio and Nickel soils that formed in gravelly outwash material.

Available water capacity is high. These soils are friable and easy to manage. Unless these soils are protected by a cover of plants, surface crusting increases runoff and the hazard of erosion. The hazards of soil blowing and water erosion are slight.

Areas that receive additional water by drainage or by water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit VIc-1; Draw range site.

Badland

Badland (Bd) consists of sloping to steep areas that have young, deeply dissected rock surfaces. These areas are in the Rio Grande Basin adjacent to flood plains of Van Horn Creek. They are mostly desolate, geologically eroded lava ash and tuff formations. Areas are irregularly oblong in shape and range from 150 to 600 acres in size. Slopes are mostly 8 to 45 percent. Elevation is mainly 3,500 to 4,000 feet. The native vegetation is a very sparse stand of desert plants of no grazing value scattered about 50 to 75 feet apart.

Badland consists of 70 to 90 percent whitish to reddish volcanic ash material on steep scarps of hills, 10 to 20 percent gravelly and stony, washed material in narrow ravines, and 10 to 20 percent Nickel gravelly soils on nearly level, narrow tops of hills.

Included in mapping are areas of Anthony and Glendale soils on the flood plains of streams and areas of Canutio and Nickel soils that formed in gravelly outwash material.

Runoff is very rapid on this land type.

Badland has little value for farming and is not suitable for range. It is better suited to recreation, water supply, and esthetic purposes than to other uses. Capability unit VIIIs-1; range site not assigned.

Boracho Series

The Boracho series consists of shallow to very shallow, well-drained, calcareous gravelly soils that are underlain by indurated caliche. These soils formed in very gravelly outwash material derived from igneous hills and mountains. They are on fans and ridges in valleys of the Davis Mountains. Elevation is mainly 4,500 to 5,000 feet. The native vegetation is grass.

In a representative profile the surface layer is grayish-brown gravelly loam about 10 inches thick that is about 45 percent, by volume, igneous and caliche rock fragments. The underlying material is pinkish-white caliche that is indurated in the upper part and strongly cemented in the lower part. It is underlain by pinkish-white very gravelly loam that is weakly cemented.

Permeability is moderate in these soils. Runoff is medium.

Boracho soils are used only for range.

Representative profile of Boracho gravelly loam in a pasture in an area of Boracho-Espy association, gently sloping, about 14 miles southeast of Fort Davis on Texas Highway 118, 0.5 mile south of junction with Farm Road 1837 at cattle pens near highway, and one-fourth mile west:

A11—0 to 2 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, platy structure; slightly hard, friable; common fine roots; 13 percent, by volume, igneous pebbles; calcareous; mildly alkaline; abrupt, smooth boundary.

A12—2 to 10 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; common fine roots; 45 percent, by volume, concretions of calcium carbonate and fragments of igneous rock; calcareous; moderately alkaline; abrupt, wavy boundary.

Ccam—10 to 20 inches, pinkish-white (5YR 8/2) caliche, laminar in upper $^1/_4$ inch, indurated in upper 4 inches; lower part is strongly cemented caliche and igneous rock fragments; clear, smooth boundary.

Cca—20 to 48 inches, pinkish-white (5YR 8/2) very gravelly loam; massive; weakly cemented; 60 percent, by volume, igneous rock fragments, $^1/_4$ inch to 10 inches in diameter.

Depth to indurated caliche ranges from 7 to 18 inches, and depth to igneous bedrock or unconsolidated material is more than 40 inches.

The A horizon ranges from 7 to 18 inches in thickness. It is grayish-brown, brown, dark-brown, or dark grayish-brown gravelly fine sandy loam, loam, silt loam, or clay loam. Reaction is mildly alkaline or moderately alkaline. Caliche and igneous coarse fragments range from 35 to 65 percent, by volume. Many of the caliche fragments are easily broken to finer particles. Secondary carbonates in the lower part of this horizon vary from soft masses to concretions and from 2 to 15 percent, by volume. The Ccam horizon is white, pinkish white, or very pale brown. It ranges from 4 to 20 inches in thickness and is 30 to 80 percent, by volume, coarse igneous rock fragments.

Boracho-Espy association, gently sloping (BeB).—This association is on old, stable, convex fans and ridges (fig. 4). It consists mainly of shallow to very shallow,

Figure 4.—Boracho-Espy association, gently sloping, is on the convex fan in the foreground. The dark, shrubby javelinabrush is an indicator plant of soils that are shallow over caliche.

well-drained gravelly soils. Slopes are mostly 1 to 5 percent, but some range to 8 percent. Areas are irregularly oblong in shape and range from 40 to 4,560 acres in size.

This association is 30 to 70 percent Boracho gravelly loam, 17 to 40 percent Espy loam, 0 to 40 percent soils that are similar to this Boracho soil but are more sloping and do not have a layer of caliche, and 10 to 30 percent other soils. The Boracho and similar soils are on areas adjacent to foot slopes of hills and on the outer boundary of this mapping unit. Espy soils are nearly level and are on hogbacks in the middle part of the unit. Included in mapping are areas of Medley and Santo Tomas soils along narrow drainageways and on the lower, outer toe of the unit. Also included are areas of Reagan and Redona soils in small, slight depressions or spots that are a few feet in size and where the layer of caliche has been destroyed by burrowing animals, by solution, or both; and a few small areas, less than 5 acres in size, of Brewster and Volco soils on igneous outcroppings.

Available water capacity is low in the soils of this association. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. The gravelly surface layer of these soils retards water erosion.

These soils are used for range. They are not suited to crops. The underlying caliche is commonly used as a source of roadbed material. Capability unit VIs-6; Shallowland range site.

Brewster Series

The Brewster series consists of shallow to very shallow, well-drained, noncalcareous stony soils that are underlain by igneous bedrock. These soils formed in loamy material that accumulated in stony rubble. They are on the sides of hills and mountains. Elevation is mainly 4,500 to 5,000 feet. The native vegetation is short and mid grasses and a few low shrubs.

In a representative profile the soil is reddish-brown, neutral gravelly loam about 7 inches thick over hard fractured rhyolite bedrock. The soil is about 50 percent, by volume, igneous fragments.

Permeability is moderate in these soils. Runoff is rapid.

Brewster soils are used only for range.

Representative profile of Brewster gravelly loam in a pasture in an area of Brewster association, hilly, about 22 miles north of Fort Davis, 1 $^{1}/_{2}$ miles southwest on county road leading up Madera Canyon from its junction with U.S. Highway 290, and 50 feet west of the road:

A1—0 to 7 inches, reddish-brown (5YR 5/3) gravelly loam, dark reddish brown (5YR 3/3) moist; weak, fine, subangular blocky and granular structure; slightly hard, friable; many roots; 50 percent, by volume, rhyolite coarse fragments that consist of 30 percent gravel, 10 percent cobbles, and 10 percent stones; neutral; abrupt, irregular boundary.

R—7 to 10 inches, fractured rhyolite bedrock.

The solum ranges from 4 to 20 inches deep to hard rock. It is 35 to 80 percent, by volume, coarse fragments that are 20 to 70 percent gravel, 0 to 25 percent cobbles, and 0 to 20 percent stones. Reaction is neutral or mildly alkaline. A few films or distinct coatings of calcium carbonate are on the faces of the fracture planes in the bedrock in some places. The total content of secondary calcium carbonate is less than 5 percent.

The A horizon ranges from 4 to 20 inches in thickness. It is reddish-brown, reddish-gray, dark reddish-gray, brown, grayish-brown, or dark grayish-brown silt loam, loam, or clay loam. The coarse fragments and the R horizon are mostly rhyolite, trachytic, and basaltic rock.

Brewster-Rock outcrop association, steep (BrF).—This association is on igneous mountains. Slopes are mostly 20 to 45 percent. Areas are irregularly oblong in shape and about 640 acres in size.

This association is 40 to 50 percent Brewster stony loam, 20 to 50 percent igneous Rock outcrop, and 10 to 30 percent other soils. Brewster soils are on side slopes. Rock outcrop is on scarps, bluffs, and sharp breaks. Included in mapping are areas of Kokernot, Mainstay, and Volco soils and soils that are similar to Brewster soils but are underlain by soft igneous rock. Small areas less than 5 acres in size of Kokernot, Mainstay, and Volco soils are common in some mapped areas.

Brewster soils are dark grayish-brown gravelly loam about 6 inches deep to fractured rhyolite bedrock. They range from 35 to 80 percent coarse fragments.

Rock outcrop contains many large stones and boulders several feet in diameter.

The soils of this association are steep and rocky. Available water capacity is low. Runoff is rapid. Rock outcrop yields water to the Brewster soils, making light rainfall effective to plants, but because of the shallow depth of the Brewster soils much of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe. The hazard of soil blowing is slight.

The soils in this association are too steep and too stony for pasture and crops. They are suitable for range. Capability unit VIIs-3; Igneous Hill and Mountain range site.

Brewster association, hilly (BsE).—This association is on igneous hills. Slopes are mostly 10 to 30 percent, but in places they are 5 to 10 percent. Areas are mainly 100 to 1,000 acres in size.

This association is 40 to 80 percent Brewster stony loam, 0 to 10 percent Rock outcrop, and 0 to 40 percent other soils that are underlain by igneous rock. Brewster soils are on side slopes, and Rock outcrop is along scarps and sharp breaks. Included in mapping are areas of Mainstay, Liv, and Kokernot soils. Mainstay and Liv

soils are in areas less than 1 acre in size, mainly near the base of hills. Kokernot soils are on divides of hills. Also included are areas of soils that are similar to Brewster soils but are underlain by soft igneous rock. Also included are areas, less than 5 acres in size, of Volco soils on the top of some hills and Boracho, Santo Tomas, and Limpia soils at the base of hills.

The Brewster soil that has the profile described as representative of the Brewster series is in this association.

The soils of this association are shallow, stony, and well drained. Available water capacity is low. Runoff is rapid. Because of stones and shallowness, plants make effective use of light rainfall, but much of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe. The hazard of soil blowing is slight. Capability unit VIIs-3; Igneous Hill and Mountain range site.

Canutio Series

The Canutio series consists of deep, excessively drained, calcareous gravelly soils. These soils formed in very gravelly and cobbly outwash material. They are on fans and hills in the Rio Grande Basin. The native vegetation is mainly creosotebush and chino grama.

In a representative profile (fig. 5) the surface layer is pale-brown, calcareous gravelly loam about 8 inches thick. The next layer is very pale brown, loose, calcareous very gravelly loam about 22 inches thick that has lime coatings on pebbles, cobbles, and stones. The lower layer is very gravelly and cobbly loam that is 30 inches thick or more. The soil is 30 percent, by volume, igneous and limestone rock fragments in the surface layer and 65 percent in the lower layers.

Permeability is rapid in these soils. Runoff is also rapid.

Canutio soils are used mainly for range.

Representative profile of Canutio gravelly loam in an area of Canutio-Nickel association, rolling, about 18 miles northwest of Valentine on U.S. Highway 90 to the junction of Farm Road 2017, 3.5 miles west on Farm Road 2017 to junction with county road, 9 miles southwest on county road, and $^{1}/_{2}$ mile north of road:

A1—0 to 8 inches, pale-brown (10YR 6/3) gravelly loam, brown (10YR 5/3) moist; weak, subangular blocky structure; soft, friable; 30 percent, by volume, igneous and limestone rock fragments that consist of 20 percent gravel and 10 percent cobbles that have thin patches of lime mainly on bottom side; calcareous; moderately alkaline; clear, smooth boundary.

Cca—8 to 30 inches, very pale brown (10YR 7/3) very gravelly loam, brown (10YR 5/3) moist; massive; loose; 65 percent, by volume, coarse fragments that consist of 40 percent gravel, 20 percent cobbles, and 5 percent stones that have patchy lime coatings, mostly igneous and limestone; calcareous; moderately alkaline; gradual, smooth boundary.

C—30 to 60 inches, very pale brown (10YR 7/3) very gravelly loam, brown (10YR 5/3) moist; massive; loose; 65 percent, by volume, coarse fragments that consist of 40 percent gravel, 20 percent cobbles, and 5 percent stones; calcareous; moderately alkaline.

The A horizon ranges from 8 to 12 inches in thickness. It is pale-brown, light brownish-gray, or pinkish-gray cobbly, gravelly, or very gravelly loam or sandy loam. It ranges from 25 to 50 percent, by volume, coarse fragments that are 20 to 50 percent gravel, 5 to 30 percent cobbles, and 0 to 20 percent stones. The Cca horizon ranges from 10 to 60 inches in thickness. It is light brownish gray, pink, or very pale brown and ranges from 35 to 70 percent, by volume, coarse fragments that are 25 to 60 percent gravel, 10 to 40 percent cobbles, and 0 to 30 percent stones. The C

Figure 5.—Profile of Canutio cobbly loam that has a large amount of coarse fragments. Tape interval is 3 inches for each white or dark section.

horizon is generally many feet thick, but in places is as shallow as 35 inches over such material as clay, lava ash, or rock.

Canutio-Badland association, rolling (CbD).—This association is on dissected gravelly outwash and lava ash deposits in the Rio Grande Basin. Slopes are 5 to 16 percent (fig. 6). Areas are irregularly oblong in shape and 120 to 7,440 acres in size.

This association is 30 to 40 percent Canutio gravelly loam, 30 to 60 percent Badland, and 10 to 20 percent Nickel soils and gravelly, stream-washed material. Canutio soils are on terraces of streams and truncated slopes of gravelly outwash material. Badland is on scarps of white to red volcanic ash and on strongly cemented silica gravel beds. The included Nickel soils are on buttes or mesas of gravelly outwash.

Canutio soils have a surface layer of pale-brown gravelly loam about 8 inches thick. The next layer, to a depth of 60 inches, is very pale brown cobbly loam.

Badland consists of rock material that supports little or no vegetation.

Available water capacity is low in the gravelly Canutio soils of this association. The gravelly surface layer retards water erosion.

These soils are not suitable for crops. They are used for range. The native vegetation is scattered creosotebush and a thin cover of chino grama, threeawn, and fluffgrass. Only a few widely scattered desert plants grow on Badland. Canutio soils in capability unit VIIs-1; Gravelly Outwash range site. Badland in capability unit VIIIs-1; range site not assigned.

Figure 6.—Canutio-Badland association, rolling. Badland part is the exposed volcanic ash in the foreground. Canutio soils are on the gravelly ridges in the background.

Canutio-Nickel association, rolling (CID).—This association is on deeply dissected gravelly outwash deposits. Slopes are mostly 5 to 16 percent (fig. 7). The area is about 9,000 acres in size.

This mapping unit is about 60 percent Canutio gravelly loam, 30 percent Nickel gravelly loam, and 10 percent gravelly streamwash material. Canutio soils are on truncated surfaces where slopes are mostly 8 to 16 percent, but some short slopes are as much as 30 percent and along stream channels; Nickel soils are on divides where slopes are mostly 5 percent but in some areas less than 5 percent; and the gravelly streamwash material is in the channel of intermittent streams.

The Canutio soil that has the profile described as representative of the Canutio series is in this association.

Nickel soils have a surface layer of light-brown gravelly loam about 10 inches thick. The next layer is white gravelly fragmental caliche about 15 inches thick. The next layer, to a depth of 40 inches, is very pale brown gravelly loam.

These are calcareous, well-drained soils of the desert area. Available water capacity is low in the soils of this association. The gravelly desert pavement retards water erosion. The hazards of soil blowing and water erosion are slight.

These soils are unsuited to crops. They are used for range that has a low carrying capacity. Capability unit VIIs-1; Canutio soils in Gravelly Outwash range site; Nickel soils in Gravelly range site.

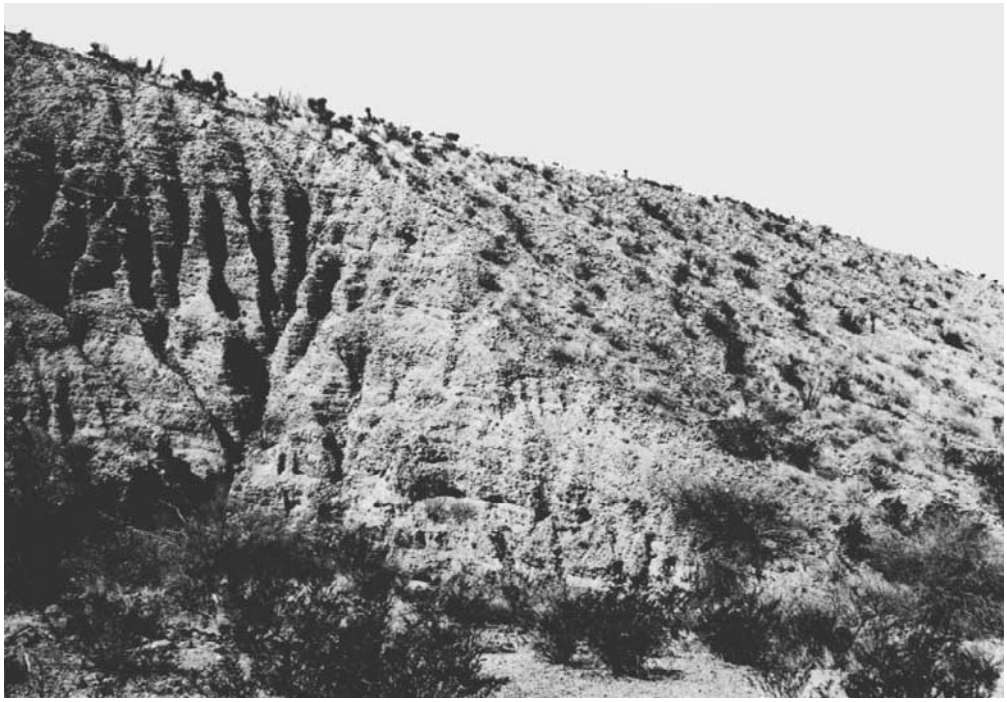

Figure 7.—Canutio-Nickel association, rolling. Canutio soils are on side slopes, and Nickel soils are on top of the fan. The bank cut shows the nature of the gravelly outwash material.

Chispa Series

The Chispa series consists of deep, well-drained, calcareous loamy soils. These soils formed in loamy sediment. They are on ridges and fans in broad plains and valleys. The native vegetation is mainly short grasses and creosotebush.

In a representative profile the surface layer is light brownish-gray fine sandy loam about 4 inches thick. The next layer is light-brown, friable sandy clay loam about 11 inches thick that has a few threads and concretions of lime. This is underlain by light reddish-brown sandy clay loam about 21 inches thick that is 15 to 30 percent, by volume, soft bodies of calcium carbonate. The underlying material to a depth of 80 inches is very pale brown sandy clay loam in the upper part and very pale brown sandy loam in the lower part.

Permeability is moderate in these soils. Runoff is medium.

Chispa soils are used only for range.

Representative profile of Chispa fine sandy loam in an area of Nickel-Chispa association, undulating, 5 $^{1}/_{2}$ miles west of Valentine at the northwest corner of Sec. 371, Block 1, GH&SA Ry. Co. Survey:

A1—0 to 4 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, platy and subangular blocky structure; slightly hard, friable; many fine roots; many fine pebbles; calcareous; moderately alkaline; abrupt, smooth boundary.

B21ca—4 to 15 inches, light-brown (7.5YR 6/2) sandy clay loam, brown (7.5YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; many fine roots; many fine, lime-coated pebbles; few threads and fine concretions of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B22ca—15 to 22 inches, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) moist; moderate, medium, subangular blocky structure;

slightly hard, friable; few fine roots; clay bridges inside peds; 30 percent, by volume, soft bodies of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B23ca—22 to 36 inches, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) moist; moderate, medium, subangular blocky structure; slightly hard, friable; few roots; many pebbles; patchy clay films; 15 percent, by volume, soft bodies of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

Cca—36 to 44 inches, very pale brown (10YR 7/3) sandy clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable; few roots; 15 percent, by volume, soft bodies of lime; calcareous; moderately alkaline; gradual, smooth boundary.

C—44 to 80 inches, very pale brown (10YR 7/3) sandy loam, brown (10YR 5/3) moist; massive; slightly hard, friable; few roots; few coarse fragments; common very fine bodies of lime; calcareous; moderately alkaline.

The solum ranges from 30 to 60 inches in thickness. Depth to the upper boundary of any horizon that is more than 15 percent calcium carbonate and more than 5 percent visible secondary carbonates ranges from 10 to 20 inches.

The A horizon ranges from 2 to 6 inches in thickness. It is light brownish-gray, pale-brown, pinkish-gray, or light-brown loam, fine sandy loam, or clay loam. The B2ca horizon ranges from 23 to 63 inches in thickness. It is light reddish-brown or light-brown clay loam, sandy clay loam, or sandy clay that is 30 to 40 percent clay. It is 15 to 40 percent, by volume, soft to weakly cemented bodies of calcium carbonate. The C horizon is very pale brown, pink, or light-brown loam, sandy loam, or sandy clay loam that is 2 to 40 percent coarse fragments. It has few to many soft masses of lime in the upper part.

Chispa-Nickel association, undulating (CnC).—This association is on fans and ridges. Slopes are plane to convex. They are mostly 1 to 8 percent but range to less than 1 percent. Areas are oblong in shape and about 40 to 600 acres in size.

This association is 68 to 80 percent Chispa soils, 10 to 30 percent Nickel soils, and 10 to 30 percent other soils. Nickel soils are on narrow aprons at the base of hills and on narrow, gravelly ridges. Included in mapping are small areas of Hodgins, Reagan, Redona, and Vado soils.

Chispa soils have a surface layer of light-brown loam about 4 inches thick. The next layer, to a depth of 36 inches, is sandy clay loam. The underlying material is pink sandy clay loam.

Nickel soils have a surface layer of pale-brown gravelly loam about 8 inches thick. The next layer is white, fragmental gravelly caliche. The underlying material, to a depth of 40 inches or more, is very pale brown very gravelly loam.

Available water capacity is low in the Nickel soils of this association and high in the Chispa soils. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

These soils are unsuited to pasture and crops. They are used mainly for range. Gravelly range site; Chispa soils in capability unit VIs-8; Nickel soils in capability unit VIIs-1.

Dalby Series

The Dalby series consists of deep, calcareous clayey soils. These soils formed in loamy alluvial sediment. They are on flats and in drainageways in broad valleys. The soil surface has a few potholes 2 to 4 feet across and some cracks that remain open most of the time. The native vegetation is mainly short grasses.

In a representative profile the surface layer is brown, calcareous clay about 4 inches thick. The next layer is brown in the upper part and light reddish brown in the

lower part. It is very firm, calcareous clay about 32 inches thick that has a few slickensides and soft masses of calcium carbonate in the lower part. The underlying material is light-brown, firm, calcareous silty clay to a depth of 70 inches that has a few soft masses of calcium carbonate.

Permeability is very slow in these soils. Runoff is also very slow.

Dalby soils are used mainly for range. A few areas are used for irrigated crops and pasture.

Dalby soils in Jeff Davis County are mapped only with Verhalen soils.

Representative profile of Dalby clay in a pasture in an area of Verhalen-Dalby association, 10 miles north of Valentine on U.S. Highway 90 and 150 yards east of the highway:

A1—0 to 4 inches, brown (7.5YR 5/2) clay, brown (7.5YR 4/2) moist; moderate, fine, subangular blocky structure; slightly hard, firm, sticky and plastic; many roots; calcareous; moderately alkaline; clear, smooth boundary.

AC1—4 to 18 inches, brown (7.5YR 5/2) clay, brown (7.5YR 4/2) moist; moderate, coarse, blocky structure; very hard, very firm, sticky and plastic; many slickensides; cracks as much as 1 inch wide; calcareous; moderately alkaline; gradual, wavy boundary.

AC2—18 to 36 inches, light reddish-brown (5YR 6/3) clay, reddish brown (5YR 5/3) moist; weak, coarse, blocky structure; very hard, very firm, sticky and plastic; a few slickensides; a few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—36 to 56 inches, light-brown (7.5YR 6/4) silty clay, brown (7.5YR 5/4) moist; medium, subangular blocky structure; slightly hard, firm, sticky and plastic; a few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, diffuse boundary.

C—56 to 70 inches, light-brown (7.5YR 6/4) silty clay, brown (7.5YR 5/4) moist; medium, subangular blocky structure; slightly hard, firm, sticky and plastic; many soft masses of crystalline salts, mainly gypsum; calcareous; moderately alkaline.

The solum ranges from 24 to 48 inches in thickness.

The A1 horizon ranges from 4 to 10 inches in thickness. It is brown, reddish gray, or pale brown. In many areas there is a surface crust of loose, subangular blocky clay loam or silty clay loam 2 to 6 inches thick. When dry, cracks 1 inch to 3 inches wide are common. The AC horizon ranges from 20 to 40 inches in thickness. It is light reddish brown, reddish brown, or brown. Slickensides are few to many. The C horizon is light-brown or light reddish-brown clay, clay loam, or silty clay. It contains few to many soft masses of calcium carbonate.

Ector Series

The Ector series consists of shallow to very shallow, well-drained, calcareous gravelly loam over limestone bedrock. These soils formed in loamy sediment that accumulated in stony rubble on hills. Elevation is mainly 3,500 to 4,500 feet. The native vegetation is generally short grasses and a spotted overstory of brush.

In a representative profile the soil is grayish-brown, calcareous gravelly loam that is about 55 percent, by volume, limestone and caliche fragments. Limestone bedrock is at a depth of about 8 inches.

Permeability is moderate in these soils. Runoff is rapid.

Ector soils are used only for range.

Representative profile of Ector gravelly loam in a pasture in an area of Ector association, hilly, 36 miles northwest of Fort Davis, 1 mile south of county line on Texas Highway 118, and 300 feet east of highway:

A1—0 to 8 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; many roots; 55 percent, by volume, limestone and caliche fragments that consist of 40 percent stones; calcareous; moderately alkaline; abrupt boundary.

R&Cca—8 to 15 inches, chalky limestone bedrock that has a 1 inch thick, hard caliche coating on surface; calcium carbonates in cracks and seams.

R—15 to 20 inches, fractured limestone bedrock.

The A horizon ranges from 5 to 20 inches deep to limestone bedrock. The amount of coarse fragments of gravel, cobble, and stone size ranges from 35 to 80 percent and increases with depth. The fragments are 30 to 75 percent gravel, 5 to 35 percent cobbles, and 0 to 20 percent stones.

The A horizon is brown, grayish-brown, or dark grayish-brown silt loam, loam, or clay loam that ranges from 25 to 35 percent clay. The hard caliche coating on the limestone bedrock ranges from 1/2 inch to 3 inches thick.

Ector association, hilly (EcE).—This association is on limestone hills. Slopes are mostly 10 to 30 percent, but they range from 8 to 40 percent. Areas are irregularly oblong in shape and range from 30 to 1,056 acres in size.

This association is 50 to 75 percent Ector gravelly loam, 0 to 20 percent Rock outcrop, and 10 to 40 percent other soils. Ector soils and included soils similar to them are on hillsides. Rock outcrop is along scarps and sharp breaks in the unit. Included in mapping are areas of Lozier, Sanderson, and Upton soils and soils that are similar to Ector soils but are underlain by soft marl. Lozier soils are on the divides of hills. Sanderson and Upton soils are on fans or aprons that extend from hills.

Available water capacity is low in the Ector soils of this association. Runoff is rapid. Because of stones and shallowness, the soils make effective use of light rainfall, but most of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe. The hazard of soil blowing is none to slight.

These soils are too stony and too shallow for pasture and crops. They are suited to range. Capability unit VIIs-4; Limestone Hill and Mountain range site.

Espy Series

The Espy series consists of well-drained, calcareous loamy soils that are shallow over caliche. These soils formed in loamy and gravelly sediment derived from igneous rock. They are on fans and ridges in valleys of the Davis Mountains. Elevation is mainly 4,500 to 5,000 feet. The native vegetation is grass.

In a representative profile (fig. 8) the surface layer is grayish-brown loam about 11 inches thick. Below this is pinkish-gray, friable clay loam that has many threads and films of lime and is about 5 inches thick. Hard caliche is at a depth of about 16 inches. It is indurated in the upper 2 inches and strongly cemented below.

Permeability is moderate in these soils. Runoff is medium.

Espy soils are used only for range.

Espy soils in Jeff Davis County are mapped only with Boracho soils.

Representative profile of Espy loam in a gravel pit in an area of Boracho-Espy association, gently sloping, 9.3 miles south of Fort Davis on Texas Highway 17 and 300 yards east of highway:

Figure 8.—Profile of Espy loam. A layer of indurated caliche is at a depth of about 16 inches.

A11—0 to 2 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, platy structure; slightly hard, friable; common fine roots; 5 percent, by volume, igneous pebbles; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—2 to 11 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; common fine roots; 12 percent, by volume, igneous pebbles; a few threads and films of calcium carbonate in lower part; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—11 to 16 inches, pinkish-gray (7.5YR 6/2) clay loam, dark brown, (7.5YR 4/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable; few fine roots; 15 percent, by volume, igneous pebbles and caliche fragments; many threads and films of calcium carbonate; calcareous; moderately alkaline; abrupt, smooth boundary.

Ccam—16 to 24 inches, white (N 8/0) caliche; indurated in upper 2 inches, strongly cemented below; few igneous pebbles; clear, smooth boundary.

Cca—24 to 48 inches, pinkish-white (7.5YR 8/2) sandy loam, pinkish gray (7.5YR 7/2) moist; weakly cemented; many strongly cemented masses; many igneous pebbles; calcareous; moderately alkaline; abrupt, smooth boundary.

IIRC—48 to 60 inches, pinkish-gray (7.5YR 7/2) tuff, light brown (7.5YR 6/4) moist; weakly cemented; easily crushed in hands; seams of calcium carbonate in fractures.

Depth to indurated caliche ranges from 11 to 20 inches. Depth to volcanic bedrock or unconsolidated contrasting material is more than 40 inches.

The A and B horizons are loam, silt loam, or clay loam that ranges from 18 to 30 percent clay. Igneous and caliche rock fragments make up 2 to 30 percent, by

volume. Many of the caliche fragments are easily broken to finer particles. The A horizon ranges from 6 to 20 inches in thickness. It is grayish brown, brown, dark brown, or dark grayish brown. It is mildly alkaline or moderately alkaline. The B horizon is pinkish gray, light brown, light brownish gray, or pale brown. It ranges from 4 to 10 inches in thickness. The Cca horizon is white, pinkish white, or very pale brown and ranges from 2 to 70 percent, by volume, coarse noncalcareous fragments. It is strongly cemented in the upper 4 to 20 inches and weakly cemented below.

Friends Series

The Friends series consists of deep, well-drained, noncalcareous soils that have a loamy surface. These soils formed in loamy to clayey sediment derived from igneous mountains. They are on foot slopes and terraces in valleys of the Davis Mountains. Elevation is mainly 5,000 to 6,250 feet. The native vegetation is mid and tall grasses and about a 50-percent overstory of trees.

In a representative profile the surface layer is dark grayish-brown, slightly acid fine sandy loam about 4 inches thick. The next layer is light brownish-gray, friable, slightly acid loam about 5 inches thick. This is underlain by brown clay about 15 inches thick. Below this is reddish-brown clay about 36 inches thick. The next layer to a depth of 75 inches is light reddish-brown clay.

Permeability is slow in these soils. Runoff is medium.

Friends soils are used only for range. They are poorly suited to pasture and crops.

Friends soils in Jeff Davis County are mapped only with Hurds soils.

Representative profile of Friends fine sandy loam in a pasture in an area of Hurds-Friends association, rolling, about 12 miles west of Fort Davis, in the center of east boundary of Sec. 12, Block WJG1, E.L.& RR Co. Survey:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky and granular structure; slightly hard, friable; common fine roots; common igneous rock fragments; slightly acid; abrupt, smooth boundary.

A2—4 to 9 inches, light brownish-gray (10YR 6/2) loam, (lark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; common fine roots; common igneous rock fragments; slightly acid; abrupt, smooth boundary.

B21t—9 to 24 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 4/2) moist; moderate, medium and coarse, blocky structure; very hard, very firm, very plastic and very sticky; few fine roots; few igneous rock fragments; medium acid; gradual, smooth boundary.

B22t—24 to 42 inches, reddish-brown (5YR 4/4) clay, reddish brown (5YR 4/3) moist; moderate, coarse, blocky structure; very hard, very firm, very plastic and very sticky; few igneous rock fragments; neutral; gradual, smooth boundary.

B23tca—42 to 60 inches, reddish-brown (5YR 4/4) clay, reddish brown (5YR 4/3) moist; weak, coarse, blocky structure; very hard, very firm, very plastic and sticky; 8 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—60 to 75 inches, light reddish-brown (5YR 6/3) clay, reddish brown (5YR 5/3) moist; weak, fine, subangular blocky structure; hard, firm; 15 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 80 inches deep to consolidated or unconsolidated material. It is 60 to 75 percent clay.

The A1 horizon ranges from 3 to 10 inches in thickness. It is very dark grayish brown, dark grayish brown, grayish brown, brown, or reddish gray. The A2 horizon is 1 to 5 inches thick. It is light brownish-gray, light-gray, or pinkish-gray loam, sandy loam, silt loam, clay loam, and their gravelly analogs. It is neutral or slightly acid. The B2t horizon ranges from 26 to 64 inches in thickness. It is brown, grayish brown, light brownish gray, pinkish gray, or reddish brown and ranges from 60 to 75 percent clay. The upper part of the B2t horizon is medium acid or slightly acid, and the lower part is slightly acid to moderately alkaline. Also, the lower part has a few to many masses of calcium carbonate and, in some places, iron and magnesium concretions. The B3ca horizon is light reddish brown, light brown, reddish brown, or brown. It ranges from 5 to 25 percent calcium carbonate.

Gageby Series

The Gageby series consists of deep, well-drained, noncalcareous loamy soils. These soils formed in stratified alluvium. They are on flood plains and low terraces of streams in the Davis Mountains. Elevation is mainly 4,500 to 5,000 feet. The native vegetation is mid and tall grasses and a few trees.

In a representative profile the surface layer is dark grayish-brown, neutral silt loam about 15 inches thick. The next layer is dark grayish brown, friable, neutral clay loam about 33 inches thick. Below this is grayish-brown, friable, calcareous clay loam about 10 inches thick that has many threads and films of lime. The lower layer is brown, friable, calcareous loam 10 inches thick that has a few films of lime.

Permeability is moderate in these soils. Runoff is slow. The soils are occasionally flooded in summer.

Gageby soils are used for irrigated crops, pasture, and range. They are poorly suited to dryland farming.

Representative profile of Gageby silt loam in an area of Gageby association, 11 miles southeast of Fort Davis on Texas Highway 118 and 100 feet west of highway, in Musquiz Creek:

A11—0 to 15 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; neutral; clear, smooth boundary.

A12—15 to 48 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; neutral; clear, smooth boundary.

A13—48 to 58 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; many threads and films of lime; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—58 to 68 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; few specks and films of lime; calcareous; moderately alkaline.

The soil is more than 60 inches deep. It is dark colored to a depth of 30 inches or more. The material between depths of 10 and 40 inches ranges from 18 to 35 percent clay. Reaction ranges from neutral in the upper part to moderately alkaline in the lower part.

The A horizon is brown, grayish-brown, or dark grayish-brown loam, silt loam, or clay loam.

Gageby association (Ga).—This association is on nearly level flood plains. Slopes are 0 to 1 percent. Areas are long and narrow along streams. They range from 20 to 7,360 acres in size.

This association is 80 to 90 percent Gageby soils and 0 to 20 percent other soils. Gageby soils are on nearly level flood plains. Included in mapping are areas of Rockhouse, Medley, and Santo Tomas soils. Rockhouse soils are on low bottoms next to the stream channel. Medley and Santo Tomas soils are on low terraces and fans, generally above the flood plain. Also included are wet soils near springs and seeps. Stream channels contain mainly gravelly and stony wash material that supports little or no vegetation.

The Gageby soil that has the profile described as representative of the Gageby series is in this association.

Available water capacity is high in the Gageby soils of this association. Unless the soils are protected by a cover of plants, they are subject to increasing runoff and erosion. The hazards of soil blowing and water erosion are slight.

These soils are poorly suited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit Vw-1; Draw range site.

Glendale Series

The Glendale series consists of deep, well-drained, calcareous loamy soils. These soils formed in stratified alluvium. They are on nearly level flood plains and low terraces of streams in the Rio Grande Basin. The native vegetation is mainly brush and short grasses.

In a representative profile the surface layer is pale-brown, calcareous loam about 12 inches thick. The next layer is light brownish-gray, friable, calcareous clay loam about 20 inches thick. Below this is pale-brown, friable, calcareous clay loam 28 inches thick that has thin layers of loam and gravelly loam.

Permeability is moderately slow in these soils. Runoff is slow to medium. The soils are occasionally flooded in summer.

Glendale soils are used mainly for range, but they are well suited to pasture and irrigated crops.

Glendale soils in Jeff Davis County are mapped only with Anthony soils.

Representative profile of Glendale loam in an area of Anthony and Glendale soils, 18 miles northwest of Valentine on U.S. Highway 90, 3.5 miles west on Farm Road 2017, 6.5 miles southwest on county road to crossing of Van Horn Creek, and 150 feet north of crossing:

A1—0 to 12 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak, platy and subangular blocky structure; slightly hard, friable; recent deposition with bedding planes; calcareous; moderately alkaline; abrupt, smooth boundary.

C1—12 to 32 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, subangular blocky structure; slightly hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

C2—32 to 60 inches, pale-brown (10YR 6/3) clay loam thinly stratified with loam and gravelly loam, brown (10YR 4/3) moist; weak, subangular blocky structure; slightly hard, friable; calcareous; moderately alkaline.

The soil is more than 60 inches deep to any restrictive layer. Threads and films of lime or other salts are common in some places. Between depths of 10 and 40 inches, stratification ranges from thin lenses of contrasting textures of loam, silt loam, or clay loam to differences in color. Also, the weighted average content of clay is 18 to 35 percent, of which less than 15 percent is coarser than very fine sand. Gravelly strata are common below a depth of 3 feet.

The A horizon ranges from 10 to 16 inches in thickness. It is light brownish-gray or pale-brown loam or clay loam. The C horizon is pale-brown, light brownish-gray, or very pale brown loam, silt loam, or clay loam.

Gullied Land

Gullied land (Gu) consists of areas of well-drained, eroded, nearly level to gently sloping soils in basins and valleys and on plains. Areas range from 10 to 240 acres in size but average about 72 acres. Slopes are 0 to 5 percent. Elevation is mainly 4,000 to 4,500 feet.

This land type is about 50 percent eroded soils that have little or no vegetation and 50 percent slightly eroded soils that support some grass. Verhalen, Dalby, and Hodgins are the main eroded soils. The erosion is active and has removed a large part of the original surface layer and exposed the underlying layers (fig. 9). The soil material is fine textured.

Runoff is medium to rapid on this land type.

Areas of Gullied land have little value as range or pasture without major reclamation. They are better suited as wildlife habitat than to other uses. Some of the areas are protected by earthen diversions to prevent future erosion. Capability unit VIIe-1; range site not assigned.

Hodgins Series

The Hodgins series consists of brownish, deep, well-drained, calcareous loamy soils. These soils formed in loamy sediment. They are in valleys and on plains. The native vegetation is mainly mid and short grasses and low shrubs.

In a representative profile the surface layer is light brownish-gray, calcareous clay loam about 8 inches thick. The next layer is pale-brown, friable, calcareous clay loam about 52 inches thick that has films and masses of lime in the lower part. The

Figure 9.—Area of Gullied land.

underlying material is light-gray, firm, calcareous silty clay about 10 inches thick that has a few soft masses of lime.

Permeability is moderate in these soils. Runoff is slow.

Hodgins soils are used for range and irrigated crops.

Representative profile of Hodgins clay loam in an area of Reagan-Hodgins association, about 3 miles northwest of Leoncito Spring, at the center of the east boundary of Sec. 49, Block 10, GH&SA Ry. Co. Survey:

A1—0 to 8 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable; many roots; many insect burrows; calcareous; moderately alkaline; clear, smooth boundary.

B2—8 to 35 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; few roots; calcareous; moderately alkaline; gradual, smooth boundary.

B2ca—35 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; few roots; many threads and films of lime, few masses of lime; calcareous; moderately alkaline; clear, smooth boundary.

Cca—60 to 70 inches, light-gray (2.5Y 7/2) silty clay, light brownish gray (2.5Y 6/2) moist; massive; hard, firm; 15 percent, by volume, subrounded limestone pebbles; few soft masses of lime; calcareous; moderately alkaline.

Depth to zone of carbonate accumulation ranges from 26 to 46 inches. Visible segregations of lime make up less than 5 percent of any horizon that has its upper boundary within a depth of 40 inches. The material between depths of 10 and 40 inches ranges from 30 to 50 percent clay and 18 to 35 percent noncarbonate clay.

The A horizon ranges from 6 to 12 inches in thickness. It is pinkish-gray, light-brown, brown, light brownish-gray, pale-brown, or grayish-brown silt loam, clay loam, loam, silty clay loam, or silty clay. The B horizon ranges from 20 to 60 inches in thickness. It is pinkish gray, pink, light brown, light gray, light brownish gray, very pale brown, pale brown, or light yellowish brown.

Hodgins clay loam, 0 to 1 percent slopes (HoA).—This soil is on plains. Areas are irregularly oblong in shape and range from 91 to 2,902 acres in size. It was mapped in greater detail and is less variable than areas of most other mapping units in the county. The mapping has been controlled to the extent that this soil can be interpreted for irrigated farming.

This soil has a surface layer of light-brown clay loam about 10 inches thick. Underlying this is pale-brown clay loam about 24 inches thick. The next layer is light-gray silty clay that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas, less than 5 acres in size, of Dalby clay in slight depressions. Also included on low, narrow ridges are areas of soils that are similar to Hodgins soils but are loam throughout.

Available water capacity is high. Runoff is slow. Unless this soil is protected by a cover of plants, surface crusting increases runoff and the hazard of erosion.

This soil is friable and easy to manage. In irrigated areas it has few limitations that restrict its use. The cropping system should include grasses, legumes, and other high-residue crops. Crop residue left on or near the surface helps reduce crusting and structural deterioration and helps keep the soil in good tilth.

A suitable irrigation system is one that meets the needs of crops, prevents water losses, and helps control erosion. In some areas diversion terraces or waterways are needed to control outside water.

Yields of irrigated crops on this soil are estimated at 1,500 pounds of lint cotton, 5,000 pounds of grain sorghum, and 6 tons of alfalfa hay. Capability unit IVc-1 and I-1 (irrigated); Deep Upland range site.

Hurds Series

The Hurds series consists of deep, well-drained gravelly soils. These soils formed in gravelly outwash derived from igneous mountains. They are on fans and terraces in narrow valleys of the Davis Mountains. Elevation is mainly 5,000 to 6,250 feet. The native vegetation is mid and tall grasses and about a 50-percent overstory of trees.

In a representative profile the surface layer is brown, slightly acid gravelly loam about 10 inches thick. The next layer is brown, friable, slightly acid very gravelly sandy clay loam about 7 inches thick that has distinct clay bridges. Below this is reddish-brown, friable, slightly acid very gravelly sandy clay loam about 8 inches thick. The underlying material to a depth of 60 inches is reddish-brown very gravelly sandy loam in the upper part and light reddish-brown very gravelly loamy sand in the lower part. The soil is 30 to 70 percent igneous pebbles, cobbles, and stones that generally increase with depth.

Permeability is moderate in these soils. Runoff is medium.

Hurds soils are used only for range. They are poorly suited to pasture and irrigated crops.

Representative profile of Hurds gravelly loam in an area of Hurds-Friends association, rolling, 39.3 miles west of Fort Davis on Texas Highway 166, 20 feet west of highway at a cut, due south of Bear Mountain, and 1.6 miles east of the intersection of the county road to Valentine:

A1—0 to 10 inches, brown (7.5YR 5/2) gravelly loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky; common roots; 30 percent, by volume, igneous rock fragments that consist of 25 percent gravel, 3 percent cobbles, and 2 percent stones; slightly acid; clear, wavy boundary.

B21t—10 to 17 inches, brown (7.5YR 5/2) very gravelly sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable, sticky; common roots; distinct clay bridges; 45 percent, by volume, igneous rock fragments that consist of 40 percent gravel, 3 percent cobbles, and 2 percent stones; slightly acid; gradual, wavy boundary.

B22t—17 to 25 inches, reddish-brown (5YR 5/4) very gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky; common roots; 50 percent, by volume, igneous rock fragments that consist of 40 percent gravel, 7 percent cobbles, and 3 percent stones; slightly acid; gradual, wavy boundary.

B23t—25 to 40 inches, reddish-brown (5YR 5/4) very gravelly sandy loam, dark reddish brown (5YR 3/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky; few roots; sandy clay loam bands, $^1/_4$ to $^1/_2$ inch thick, about 3 inches apart; 60 percent, by volume, igneous rock fragments that consist of 45 percent gravel, 10 percent cobbles, and 5 percent stones; slightly acid; clear, wavy boundary.

Bt&C—40 to 60 inches, light reddish-brown (5YR 6/4) very gravelly loamy sand, reddish brown (5YR 4/4) moist; massive; hard, friable; sandy loam bands, $^1/_4$ to $^1/_2$ inch thick, about 2 inches apart; 70 percent, by volume, igneous rock fragments that are 50 percent gravel, 15 percent cobbles, and 5 percent stones; slightly acid.

The solum ranges from 34 to 60 inches in thickness. Between depths of 10 to 40 inches the soil ranges from 18 to 35 percent clay.

The A horizon ranges from 6 to 18 inches in thickness. It is brown, reddish-gray, or reddish-brown gravelly or very gravelly sandy loam, loam, or sandy clay loam. It ranges from 15 to 50 percent, by volume, coarse fragments that are 15 to 50 percent gravel and 0 to 15 percent cobbles or stones. Reaction is neutral or slightly acid. The B2t horizon ranges from 10 to 50 inches in thickness. It is reddish-brown, brown, light-brown, or light reddish-brown very gravelly sandy loam or sandy clay loam that has lamellae of sandy clay loam, clay loam, or sandy clay. Reaction is slightly acid to medium acid. The C horizon is light reddish-brown, light-brown, or brown very gravelly loam, sandy loam, or loamy sand. In places it has secondary carbonate accumulations. The B2t and C horizons range from 35 to 75 percent, by volume, coarse fragments that are 35 to 70 percent gravel, 2 to 20 percent cobbles, and 0 to 20 percent stones.

Hurds-Friends association, rolling (HuD).—This association is in high valleys of the Davis Mountains (fig. 10). Areas are irregularly oblong in shape and about 100 to 500 acres in size.

This association is 35 to 45 percent Hurds soils, 10 to 30 percent Friends soils, 10 to 20 percent Mitre soils, 0 to 10 percent Limpia soils, and 15 to 25 percent other soils. Hurds soils are on oblong fans where slopes are mostly 8 to 16 percent but range to 20 percent. Friends soils are on terraces or drainageways where slopes are mainly 5 to 8 percent but range to less than 5 percent. Mitre and Limpia soils are on the higher, older fans next to the slopes of mountains. Included in mapping are areas of Medley, Santo Tomas, Boracho, Rockhouse, and Brewster soils. Medley and Santo Tomas soils are on fans or terraces next to stream channels. Boracho soils occur with Mitre and Limpia soils. Rockhouse soils are on low bottoms of streams that drain the area. Most soil areas range from 5 to 40 acres in size.

Hurds soils are gravelly, and Friends soils are clayey.

The Hurds and Friends soils in this association have the profile described as representative of their respective series.

Figure 10.—Hurds-Friends association, rolling, in high narrow valleys of the Davis Mountains (center part of picture). On the hillsides are Mainstay, Liv, and Brewster soils.

Available water capacity is medium in the Hurds soils of this association. Their gravelly material retards erosion. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

Friends soils in this association are slowly permeable. Available water capacity is high. The hazard of water erosion is severe unless they are protected by a cover of grass. The hazard of soil blowing is slight.

Because of slope, the content of gravel in the Hurds soils, and climate on the Friends soils, these soils are poorly suited to crops and pasture. They are used for range. Foothill Slope range site; Hurds soils in capability unit VIs-4; Friends soils in capability unit VIe-2.

Ima Series

The Ima series consists of deep, well-drained, calcareous loamy soils. These soils formed in loamy sediment. They are on ridges, scarps, and divides in valleys and on plains. The native vegetation is mid and short grasses and a few low shrubs.

In a representative profile the surface layer is pinkish-gray and brown, calcareous fine sandy loam about 8 inches thick. The next layer is light-brown, calcareous fine sandy loam about 38 inches thick. The underlying material is pinkish-gray, calcareous gravelly sand about 19 inches thick.

Permeability is moderately rapid in these soils. Runoff is medium.

Ima soils are used mainly for range. They are poorly suited to irrigated crops or pasture.

Representative profile of Ima fine sandy loam in an area of Ima-Hodgins association, gently sloping, 14 miles northwest of Valentine on U.S. Highway 90, one-half mile west on road to a house, and 0.5 mile west on ranch road, 100 feet north of road, Sec. 426, Block 4, H&TC Ry. Co. Survey, 4 miles east and one-fourth mile north of the southwest corner:

A11—0 to 3 inches, pinkish-gray (7.5YR 6/2) fine sandy loam, brown (7.5YR 4/2) moist; weak, fine, platy and subangular blocky structure; loose, soft; many roots; calcareous; moderately alkaline; clear, smooth boundary.

A12—3 to 8 inches, brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable; many roots; few volcanic pebbles; calcareous; moderately alkaline; gradual, smooth boundary.

B21—8 to 18 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; common roots; calcareous; moderately alkaline; gradual, smooth boundary.

B22—18 to 46 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak, fine, subangular blocky structure; loose, very friable; calcareous; moderately alkaline; clear, smooth boundary.

C—46 to 65 inches, pinkish-gray (7.5YR 7/2) gravelly sand, brown (7.5YR 5/2) moist; single grained; loose; 20 percent, by volume, volcanic pebbles; calcareous; moderately alkaline.

The solum ranges from 30 to more than 50 inches in thickness.

The A horizon ranges from 6 to 14 inches in thickness. It is pinkish-gray, brown, reddish-gray, reddish-brown, or light brownish-gray fine sandy loam or loam. The B horizon is 18 to 38 inches thick. It is light brown, light reddish-brown, or reddish-brown fine sandy loam or loam that is less than 18 percent clay. The C horizon is generally one value higher in color than the B horizon.

Ima soils in Jeff Davis County are outside the range of the Ima series in that the A horizon has chroma of 2 and slightly lower value when moist than is typical for the series. This difference does not affect the use and management of the soils.

Ima-Hodgins association, gently sloping (IhB).—This association is on plains and in valleys. Slopes are mainly 2 to 5 percent, but they range from 1 to 8 percent. Areas are 30 to 1,800 acres in size.

This association is 60 to 80 percent Ima fine sandy loam, 10 to 40 percent Hodgins soils, and 0 to 30 percent other soils. Included in mapping are areas of Chispa, Redona, and Dalby soils. As much as 40 percent of these included soils is on the outer edge of the mapped areas where they have been overblown by fine sandy loam.

The Ima soil that has the profile described as representative of the Ima series is in this association.

Hodgins soils have a surface layer of light brownish-gray loam about 10 inches thick. The next layer is very pale brown clay loam about 55 inches thick. The underlying material, to a depth of 70 inches or more, is pinkish-gray silty clay. The Hodgins soils have a surface layer of fine sandy loam where they have been overblown.

Available water capacity is moderate in the Ima soils of this association and high in the Hodgins soils. Unless the soils are protected by a cover of grass, the hazard of soil blowing is severe. The hazard of water erosion is moderate. These soils are unsuited to crops because of low rainfall. They are used mainly for range. Ima soils in capability unit VIe-1; Sandy Loam range site. Hodgins soils in capability unit IVe-2; Deep Upland range site.

Kokernot Series

The Kokernot series consists of shallow, well-drained, noncalcareous gravelly loamy soils that are underlain by igneous bedrock. These soils formed in residuum derived from fine-grained igneous rock. They are on mesas in the Davis Mountains. Elevation is mainly 4,500 to 5,000 feet. The native vegetation is short and mid grasses and a few widely scattered low shrubs.

In a representative profile the surface layer is brown, neutral gravelly sandy loam about 3 inches thick. The next layer is reddish-brown, friable, neutral gravelly loam about 5 inches thick. Below this is reddish-brown, firm, neutral gravelly clay loam about 10 inches thick. Depth to volcanic bedrock is about 18 inches.

Permeability is moderate in these soils. Runoff is medium.

Kokernot soils are used only for range.

Representative profile of Kokernot gravelly sandy loam on Grierson Mesa in an area of Kokernot-Brewster association, gently sloping, 10 miles southeast of Fort Davis on Texas Highway 118, miles northeast on a county road to a house, 3 miles on ranch road to Grierson Mesa, 20 feet north of road, Sec. 21, Block WJG 10, one-half mile west of the southeast section corner and one-fourth mile north of the south section line:

A1—0 to 3 inches, brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 3/4) moist; moderate, fine, subangular blocky and granular structure; hard, friable; many roots; about 20 percent, by volume, pebbles, mostly less than $^1/_2$ inch in diameter; neutral; clear, smooth boundary.

B1t—3 to 8 inches, reddish-brown (5YR 5/4) gravelly loam, dark reddish brown (5YR 3/4) moist; moderate, fine, subangular blocky structure; hard, friable; many roots; about 20 percent, by volume, coarse fragments, mostly less than $^1/_2$ inch in diameter; neutral; clear, smooth boundary.

B21t—8 to 14 inches, reddish-brown (5YR 5/4) gravelly clay loam, dark reddish brown (5YR 3/4) moist; moderate, fine, subangular blocky structure; hard,

firm; many roots; few thin, patchy clay films; about 30 percent, by volume, coarse fragments, mostly less than 1 inch in diameter; neutral; clear, irregular boundary.

B22t—14 to 18 inches, reddish-brown (5YR 5/4) gravelly clay loam, dark reddish brown (5YR 3/4) moist; moderate, fine, subangular blocky structure; hard, firm; few roots; patchy clay films; about 30 percent, by volume, coarse fragments, mostly less than 3 inches in diameter; neutral; abrupt, irregular boundary.

R—18 to 26 inches, trachyte bedrock; a few seams of clay as much as 1 inch in diameter in fractures; partly weathered in upper 2 or 3 inches.

The solum ranges from 12 to 20 inches deep to hard rock. Reaction ranges from mildly alkaline to slightly acid.

The A and B horizons are brown or reddish brown. The A horizon ranges from 2 to 6 inches in thickness. It is sandy loam or gravelly sandy loam. The Bt horizon is 7 to 16 inches thick. It is loam or clay loam that is 18 to 35 percent clay, of which 15 percent is coarser than very fine sand. The Bt horizon is 15 to 35 percent, by volume, coarse fragments.

Kokernot-Brewster association, gently sloping (KbB).—This association is on divides of igneous hills. Slopes are mainly 1 to 3 percent, but they range to 5 percent. Areas are irregularly oblong and range from 160 to 2,500 acres in size.

This association is 40 to 75 percent Kokernot loam, 25 to 50 percent Brewster stony loam, and 0 to 20 percent other soils. Included in mapping are small areas, less than 5 acres in size, of Espy and Boracho soils on remains of older alluvium; Gageby and Santo Tomas soils in narrow drainageways; and Rock outcrop, mainly on narrow breaks. These included soils make up less than 20 percent of this mapping unit. Also included in a few places are areas of soils that are similar to Kokernot soils, but the solum is more than 20 inches thick.

The Kokernot soil in this association has the profile described as representative of the Kokernot series.

Brewster soils are brown gravelly loam that is more than 35 percent coarse fragments and 8 inches deep to fractured bedrock.

The soils of this association are well drained. Available water capacity is low. Runoff is medium to rapid. The hazard of water erosion is moderate to severe, and the hazard of soil blowing is slight.

These soils are used only for native range. They support a moderate cover of grass and a few widely scattered, low shrubs, Kokernot soils in capability unit VIs-7; Shallowland range site. Brewster soils in capability unit VIIs-3; Igneous Hill and Mountain range site.

Limpia Series

The Limpia series consists of deep, well-drained, noncalcareous gravelly soils. These soils formed in stony and gravelly outwash material from igneous mountains. They are on fans and terraces in mountain valleys. Elevation is 4,000 to 5,000 feet.

In a representative profile (fig. 11) the surface layer is dark reddish-gray, neutral gravelly loam about 12 inches thick. This is underlain by reddish-brown, firm, neutral very gravelly clay about 48 inches thick.

Permeability is slow in these soils. Runoff is medium.

Limpia soils are used only for range. They are poorly suited to pasture and irrigated crops.

Figure 11.—Profile of Limpia gravelly loam showing some of the stony and gravelly material in which this soil formed.

Representative profile of Limpia gravelly loam in a pasture in an area of Limpia and Mitre soils, gently sloping, 18 miles northeast of Fort Davis on Texas Highway 17 to the junction of county road down Limpia Canyon, 4 miles east on county road, and 200 feet north of road:

A1—0 to 12 inches, dark reddish-gray (6YR 4/2) gravelly loam, dark reddish brown (5YR 2/2) moist; moderate, fine, granular and subangular blocky structure; slightly hard, friable; many fine roots; 55 percent, by volume, igneous coarse fragments that consist of 25 percent gravel, 20 percent cobbles, and 10 percent stones; neutral; clear, smooth boundary.

B21t—12 to 30 inches, reddish-brown (5YR 5/3) very gravelly clay, dark reddish brown (5YR 3/3) moist; moderate, fine, blocky structure; slightly hard, firm, sticky and plastic; common fine roots; 65 percent, by volume, igneous coarse fragments that consist of 35 percent gravel, 20 percent cobbles, and 10 percent stones; neutral; gradual, smooth boundary.

B22t—30 to 60 inches, reddish-brown (5YR 4/4) very gravelly clay, dark reddish brown (5YR 3/4) moist; moderate, fine, blocky structure; hard, firm, sticky and plastic; few fine roots; 65 percent, by volume, igneous coarse fragments that consist of 35 percent gravel, 20 percent cobbles, and 10 percent stones; neutral.

The solum ranges from 40 to 100 inches deep to bedrock or unconsolidated material. It is 35 to 80 percent, by volume, coarse fragments that are 20 to 70 percent gravel, 5 to 40 percent cobbles, and 0 to 20 percent stones.

The A horizon ranges from 5 to 16 inches in thickness. It is brown, reddish-gray, dark reddish-gray, or reddish-brown gravelly loam, sandy clay loam, or clay loam. The upper part of the B2t horizon is 10 to 25 inches thick and is the same color as the A horizon. The lower part of the B2t horizon is reddish-brown or yellowish-red stony or very gravelly clay. The B2t horizon is 35 to 60 percent clay. Reaction is neutral or mildly alkaline. Secondary carbonate accumulations are in the lower part of the B2t horizon in places.

Limpia and Mitre soils, gently sloping (LmB).—This mapping unit is on convex fans. Slopes are 1 to 5 percent. Areas are irregularly oblong in shape and about 600 acres in size.

This mapping unit is 40 to 80 percent Limpia soils, 0 to 40 percent Mitre soils, and 0 to 30 percent other soils, such as Boracho, Musquiz, Redona, Rockhouse, Santo Tomas, and Medley. Limpia soils are nearly level and receive extra water. Mitre soils are slightly higher than Limpia soils and receive extra water. Mitre soils are slightly higher than Limpia soils and receive little or no extra water from higher areas. Boracho soils are mainly on the outer edge of the unit and are more sloping. Rockhouse and Santo Tomas soils are along narrow drainageways. Small areas, less than 5 acres in size, of Musquiz and Redona soils are present in places. Patterns of soil distribution within the mapped areas are not uniform and occur without regularity.

The Limpia and Mitre soils in this association have the profile described as representative of their respective series.

Available water capacity is low. Runoff is medium. The hazard of water erosion is slight because the surface is covered with pebbles and stones (fig. 12).

Figure 12.—Limpia and Mitre soils, gently sloping, have many stones on their surface.

These soils are not suited to irrigated crops. They are used mainly for native range. Foothill Slope range site; Limpia soils in capability unit VIs-4; Mitre soils in capability unit VIs-7.

Liv Series

The Liv series consists of moderately deep, well-drained, noncalcareous gravelly soils that are underlain by igneous bedrock. These soils formed in silty loess that accumulated in stony rubble. They are on mountain slopes. Elevation is mainly 5,000 to 6,250 feet. The native vegetation is mainly mid and short grasses and, in a few areas, an overstory of low shrubs and trees.

In a representative profile the surface layer is very dark grayish-brown, neutral cobbly silt loam about 9 inches thick. The next layer is very dark grayish-brown gravelly clay about 8 inches thick. Below this to a depth of 38 inches is gravelly clay that is dark reddish gray in the upper part and reddish brown in the lower part. The underlying material to a depth of 60 inches or more is tuffaceous rock. The soil is about 50 percent, by volume, igneous fragments that are $^{1}/_{2}$ inch to 10 inches or more in diameter.

Permeability is moderately slow in these soils. Runoff is rapid.

Liv soils are used only for range.

Representative profile of Liv cobbly silt loam in an area of Liv-Mainstay-Rock outcrop association, steep, 12.8 miles west of Fort Davis on Texas Highway 118, 100 feet north of highway, on the south face of Mount Locke:

A1—0 to 9 inches, very dark grayish-brown (10YR 3/2) cobbly silt loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; slightly hard, friable; many fine roots; 50 percent, by volume, igneous rock fragments that consist of 20 percent cobbles, 20 percent gravel, and 10 percent stones; neutral; clear, smooth boundary.

B21t—9 to 17 inches, very dark grayish-brown (10YR 3/2) gravelly clay, very dark brown (10YR 2/2) moist; strong, fine, angular blocky structure; hard, firm, plastic and nonsticky; many roots; continuous clay films; about 55 percent, by volume, igneous rock fragments that consist of 25 percent gravel, 20 percent cobbles, and 10 percent stones; slightly acid, clear boundary.

B22t—17 to 23 inches, dark reddish-gray (5YR 4/2) gravelly clay, dark reddish brown (5YR 3/3) moist; strong, fine, angular blocky structure; hard, firm, plastic and sticky; about the same amount and kind of coarse fragments as B21t horizon; slightly acid; gradual, smooth boundary.

B2tca—23 to 38 inches, reddish-brown (5YR 4/3) gravelly clay, dark reddish brown (5YR 3/3) moist; moderate, medium, angular blocky structure; hard, firm, plastic and sticky; continuous clay films; about 60 percent, by volume, igneous rock fragments that consist of 30 percent gravel, 20 percent cobbles, and 10 percent stones; many soft masses of calcium carbonate; neutral; clear, smooth boundary.

Cca—38 to 44 inches, light reddish-brown (5YR 6/3) and reddish-gray (5YR 5/2) tuffaceous rock; weakly cemented, fragile fragments; soft masses of calcium carbonate in fractures; gradual, irregular boundary.

C—44 to 60 inches, light-olive tuffaceous rock; weakly cemented; fractured; lime coatings in fractures.

The solum ranges from 20 to 40 inches deep to bedrock. It is 35 to 80 percent, by volume, angular igneous rock fragments that are 15 to 60 percent gravel, 5 to 30 percent cobbles, and 0 to 30 percent stones.

The A horizon ranges from 4 to 14 inches in thickness. It is very dark grayish-brown, dark grayish-brown, and dark-brown silt loam, loam, or sandy loam. The B2t

horizon is 12 to 41 inches thick. It is very dark grayish brown, dark reddish gray, dark reddish brown, reddish brown, dark brown, and dark grayish brown. It is neutral to slightly acid. Clay content of fines is 50 to 70 percent. The underlying igneous material ranges from weakly cemented tuff and ash to weathered basalt, rhyolite, or trachyte. In most places there are few to many soft masses of calcium carbonate in the lower part of the B2t horizon and the upper part of the C horizon.

Liv-Mainstay-Rock outcrop association, steep (LrF).—This association is on igneous mountains. Slopes are mostly 20 to 45 percent. Areas are irregularly oblong in shape and range from 160 to 5,000 acres in size.

This association is 20 to 40 percent Liv cobbly silt loam, 10 to 20 percent Mainstay cobbly silt loam, 20 to 40 percent Rock outcrop, and 10 to 50 percent other soils. Liv and Mainstay soils are on mountainsides. Rock outcrop is along escarpments and sharp breaks of slopes (fig. 13). Included in mapping are areas of Brewster, Sproul, Limpia, and Santo Tomas soils. Brewster and Sproul soils are near the top of mountains. Limpia and Santo Tomas soils are on fans at the base of mountains.

The Liv soils in this association have the profile described as representative of the Liv series.

Mainstay soils have a surface layer of very dark grayish-brown cobbly silt loam about 3 inches thick. The next layer is very dark grayish-brown gravelly clay about 3 inches thick. Below this is reddish-brown gravelly clay about 10 inches thick. The underlying material is fractured igneous bedrock.

Rock outcrop consists of igneous rock masses, hills, peaks, scarps, canyon walls, and rubble masses.

Figure 13.—Liv-Mainstay-Rock outcrop association, steep. Liv and Mainstay soils are on mountainsides, and Rock outcrop is on scarps near the top of mountains.

The soils of this association are well drained. Available water capacity is medium in the Liv soils and low in the Mainstay soils. Runoff is rapid, and permeability is moderate to moderately slow. Light rainfall is beneficial to the vegetation, but much of the water from heavy rainfall runs off. The surface mantle of stones retards erosion. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

These soils are used for range. Capability unit VIIs-3; Igneous Hill and Mountain range site.

Loghouse Series

The Loghouse series consists of deep, well-drained gravelly soils. These soils formed in stony outwash material derived from igneous mountains. They are on fans and terraces in narrow valleys in the Davis Mountains. Elevation is mainly 6,000 to 7,500 feet. The native vegetation is forest or tree cover.

In a representative profile a mat of leaves and stems about 2 inches thick is on the surface. The surface layer is dark grayish-brown, neutral gravelly sandy loam about 6 inches thick. The next layer is light brownish-gray, friable, medium acid gravelly sandy loam about 8 inches thick. Below this to a depth of 70 inches or more is very gravelly sandy loam that is brown in the upper part and reddish brown in the lower part.

Permeability is moderately rapid in these soils. Runoff is medium to rapid.

Loghouse soils are used mainly for range. They are well suited to trees.

Representative profile of Loghouse gravelly sandy loam in a pasture in an area of Loghouse association, rolling, 15 miles west of Fort Davis on Texas Highway 166, 6 $^{1}/_{2}$ miles north of Highway on a ranch road leading to upper part of Limpia Canyon, and 150 yards west of stock pens:

O1—2 inches to 0, mat of oak, pine, and juniper leaves and stems.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; soft, very friable; many roots; 40 percent, by volume, igneous rock fragments that consist of 25 percent gravel, 10 percent cobbles, and 5 percent stones; neutral; clear, smooth boundary.

A2—6 to 14 inches, light brownish-gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many roots; 45 percent, by volume, igneous rock fragments that consist of 30 percent gravel, 10 percent cobbles, and 5 percent stones; medium acid; clear, smooth boundary.

B21t—14 to 30 inches, brown (7.5YR 5/2) very gravelly sandy loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky structure; hard, firm; clay bridges between sand grains, common clay films on fragments; common fine roots; 65 percent, by volume, igneous rock fragments that consist of 45 percent gravel, 15 percent cobbles, and 5 percent stones; medium acid; gradual, smooth boundary.

B22t—30 to 70 inches, reddish-brown (5YR 5/3) very gravelly sandy loam, reddish brown (5YR 5/4) moist; moderate, medium, subangular blocky structure; very hard, very firm; clay bridges between sand grains, clay films on fragments; few roots; 70 percent, by volume, igneous rock fragments that consist of 50 percent gravel, 15 percent cobbles, and 5 percent stones; medium acid.

The soil ranges from 60 to 100 inches or more in thickness.

The O horizon is 0 to 6 inches thick. The A1 horizon ranges from 4 to 9 inches in thickness. It is very dark grayish-brown, dark grayish-brown, grayish-brown, or brown gravelly loam or gravelly sandy loam. Reaction is neutral or slightly acid. The A2 horizon is gravelly sandy loam or gravelly loam 4 to 24 inches thick. It is light

brownish gray, pale brown, or pinkish gray. Reaction is slightly acid or medium acid. The A1 and A2 horizons range from 22 to 50 percent, by volume, coarse fragments that are 15 to 45 percent gravel, 5 to 20 percent cobbles, and 0 to 20 percent stones. The B21t horizon is 8 to 24 inches thick. The B2t horizon is brown or reddish-brown gravelly or very gravelly sandy loam or sandy clay loam that is 12 to 35 percent clay. Reaction is medium acid to strongly acid. It is 40 to 85 percent, by volume, coarse fragments that are 20 to 80 percent gravel, 5 to 20 percent cobbles, and 0 to 20 percent stones. In most places the percentage of coarse fragments increases with depth in these soils.

Loghouse association, rolling (LsD).—This association is on fans and terraces. Slopes are mainly 5 to 16 percent, but they range from less than 5 percent to 20 percent. Areas are irregularly oblong in shape and 40 to 600 acres in size.

This association is 30 to 70 percent Loghouse soils; 20 to 40 percent soils that are similar to Loghouse soils, but the surface layer is thick and dark colored; and 10 to 30 percent other soils. Loghouse soils are on deeply dissected fans to low terraces. Gageby soils and the soils that are similar to Loghouse soils are on the narrow flood plains of streams. Included in mapping are areas of Gageby, Hurds, and Friends soils.

The Loghouse soil that has the profile described as representative for the series is in this association.

The soils in this association are well drained. Available water capacity is low. Permeability is moderately rapid, and runoff is medium to rapid. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

These soils are too stony for crops. They are used mainly for native range. They are also well suited to trees (fig. 14). Capability unit VIs-4; Canyon range site.

Figure 14.—Stand of ponderosa pine on Loghouse association, rolling. The soil surface is covered by a large amount of litter.

Lozier Series

The Lozier series consists of very shallow to shallow, well-drained, calcareous gravelly soils that are underlain by limestone. These soils formed in calcareous sediment that accumulated in the stony mantle of hills. The native vegetation is mainly low shrubs.

In a representative profile the soil is about 6 inches of light brownish-gray gravelly loam over grayish limestone bedrock.

Permeability is moderate in these soils. Runoff is medium to rapid.

Lozier soils are used only for range.

Representative profile of Lozier gravelly loam in an area of Lozier association, undulating, about 26 miles north of Fort Davis, on Sec. 23, Block 57, T&P Ry. Co. Survey, in center of east boundary:

A1—0 to 6 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular and subangular blocky structure; slightly hard, friable; few roots; 40 percent, by volume, caliche-coated limestone fragments that consist of 25 percent gravel, 10 percent cobbles, and 5 percent stones; calcareous; moderately alkaline; abrupt, irregular boundary.

R&Cca—6 to 12 inches, grayish limestone bedrock; very hard; $^1/_2$ inch thick caliche coating on surface; calcium carbonate in seams and fractures; gradual, wavy boundary.

R—12 to 20 inches, fractured limestone bedrock.

The soil ranges from 35 to 80 percent, by volume, coarse fragments that are 15 to 60 percent gravel, 2 to 20 percent cobbles, and 0 to 20 percent stones. Caliche coatings on fragments vary from faint films to 1 inch in thickness. Depth to hard limestone and thickness of the A horizon range from 4 to 12 inches.

The A horizon is light brownish-gray or light-gray loam or clay loam that ranges from 15 to 35 percent clay. The caliche coatings on the limestone bedrock range from $^1/_4$ inch to 3 inches in thickness.

Lozier association, undulating (LtC).—This association is on low limestone hills. Slopes are convex. They are mostly 3 to 8 percent, but they range to 12 percent. Areas are irregularly oblong in shape and about 600 acres in size.

This association is 50 to 80 percent Lozier soils, 0 to 30 percent Ector soils, 0 to 20 percent Rock outcrop, and 10 to 20 percent other soils. Rock outcrop is on sharp ledges or slopes and breaks. Included in mapping are areas of Hodgins, Sanderson, and Upton soils that are deeper than Lozier and Ector soils.

The Lozier soil that has the profile described as representative of the Lozier series is in this association.

Ector soils are similar to Lozier soils but are darker colored.

The soils in this association are very shallow to shallow. Available water capacity is low. In most areas the soils have a surface crust, which causes slow infiltration and considerable runoff. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

These soils are too shallow and too stony for pasture and crops. They are used mainly for range. Capability unit VIIs-4; Limestone Hill and Mountain range site.

Lozier-Rock outcrop association, hilly (Lu E).—This association is on limestone hills. Slopes are mostly 10 to 30 percent, but some slopes are 5 to 10 percent. Areas are irregularly oblong in shape and range from 100 to about 1,000 acres in size.

This association is 50 to 70 percent Lozier soils, 20 to 40 percent Rock outcrop, and 0 to 20 percent other soils. Lozier soils are on side slopes. Rock outcrop is along

sharp breaks and scarps. Included in mapping are areas of Sanderson soils in narrow ravines and Upton soils at the base of the hills on narrow fans or aprons.

Lozier soils are about 5 inches of light brownish-gray gravelly loam over limestone bedrock. Rock outcrop consists of rough areas that have many large boulders many feet across.

The soils of this association are steep and rocky. Available water capacity is low. Runoff is rapid. Rock outcrop yields water to the Lozier soils, making light rainfall effective; but because of the very shallow depth of the Lozier soils, much of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe. The hazard of soil blowing is slight.

These soils are used for range. Capability unit VIIs-4; Limestone Hill and Mountain range site.

Madrone Series

The Madrone series consists of steep, moderately deep, well-drained, noncalcareous cobbly soils that are underlain by igneous bedrock. These soils formed in a stony mantle. They are on hills and mountains at the higher elevations of the Davis Mountains. Elevation is mainly 6,000 to 7,500 feet. The native vegetation is mainly trees and some grasses.

In a representative profile (fig. 15) the surface layer is dark grayish-brown, neutral cobbly silt loam about 5 inches thick. The next layer is pale-brown, very friable, strongly acid cobbly loam about 4 inches thick. Below this is brown, very strongly acid cobbly clay that extends to a depth of 36 inches. The underlying material is fractured igneous bedrock.

Figure 15.—Profile of Madrone cobbly silt loam that formed in stony rubble of a mountainside.

Permeability is moderately slow in these soils. Runoff is medium to rapid.

Madrone soils are used mainly for range. They are suited to trees.

Madrone soils in Jeff Davis County are mapped only with Puerta soils.

Representative profile of Madrone cobbly silt loam in an area of Puerta-Madrone association, steep, 11 $^{1}/_{2}$ miles west of McDonald Observatory on Texas Highway 118 to junction of ranch road leading up Loghouse Canyon and 3 miles south on ranch road at a cut on side of road:

O—1 inch to 0, partly decomposed organic material; abrupt, smooth boundary.

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) cobbly silt loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; soft, very friable; many roots; 45 percent, by volume, igneous rock fragments that consist of 20 percent gravel, 20 percent cobbles, and 5 percent stones; neutral; clear, smooth boundary.

A2—5 to 9 inches, pale-brown (10YR 6/3) cobbly loam, brown (10YR 4/3) moist; moderate, fine, granular structure; soft, very friable; many roots; 45 percent, by volume, igneous rock fragments that consist of 20 percent gravel, 20 percent cobbles, and 5 percent stones; strongly acid; clear, smooth boundary.

B21t—9 to 22 inches, brown (7.5YR 5/2) cobbly clay, brown (7.5YR 4/2) moist; strong, medium, blocky structure; hard, firm, plastic and sticky; few roots; few distinct clay films; lenses of material from A2 horizon in vertical cracks; 50 percent, by volume, igneous rock fragments that consist of 20 percent gravel, 20 percent cobbles, and 10 percent stones; very strongly acid; clear, smooth boundary.

B22t—22 to 36 inches, brown (7.5YR 5/2) cobbly clay, brown (7.5YR 4/2) moist; few reddish-brown (5YR 5/3) mottles; moderate, medium, angular blocky structure; very hard, very firm, plastic and sticky; 50 percent, by volume, igneous rock fragments that consist of 20 percent gravel, 20 percent cobbles, and 10 percent stones; very strongly acid; abrupt, irregular boundary.

R—36 to 40 inches, fractured igneous bedrock; clay from B22t horizon in seams.

Depth to bedrock ranges from 21 to 40 inches. The solum is 35 to 80 percent, by volume, igneous coarse fragments that are 15 to 50 percent gravel, 5 to 40 percent cobbles, and 0 to 30 percent stones. In places there are stones 10 to 36 inches in diameter.

The O horizon ranges from 0 to 4 inches in thickness. The A1 horizon is 4 to 6 inches thick. It is dark grayish-brown, grayish-brown, or brown gravelly or cobbly silt loam, clay loam, loam, or sandy loam. The A2 horizon ranges from 4 to 12 inches in thickness. It is pinkish-gray, light brownish-gray, pale-brown, or light-gray gravelly or cobbly clay loam, loam, or sandy loam. The B2t horizon is 6 to 38 inches thick. It is brown, grayish-brown, or reddish-brown cobbly or gravelly clay or silty clay.

Mainstay Series

The Mainstay series consists of shallow, well-drained, noncalcareous cobbly soils that are underlain by igneous bedrock. These soils formed in loamy material that accumulated in stony rubble. They are on mountainsides. Elevation is mainly 5,000 to 6,250 feet. The native vegetation is mainly mid and short grasses and, in a few areas, an overstory of trees and low shrubs.

In a representative profile the surface layer is very dark grayish-brown, neutral cobbly silt loam about 3 inches thick. The next layer, to a depth of 16 inches, is firm gravelly clay that is very dark grayish brown in the upper part and reddish brown in the lower part. The underlying material is igneous bedrock.

Permeability is moderate in these soils. Runoff is rapid.

Mainstay soils are used only for range.

Representative profile of Mainstay cobbly silt loam in an area of Mainstay-Brewster association, hilly, on the east face of a mountain in the Davis Mountain State Park, 300 feet north of a water tank for the Indian Lodge:

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) cobbly silt loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; slightly hard, friable; many fine roots; 50 percent, by volume, igneous rock fragments that consist of 20 percent gravel, 20 percent cobbles, and 10 percent stones; neutral; clear, smooth boundary.

B21t—3 to 6 inches, very dark grayish-brown (10YR 3/2) gravelly clay, very dark brown (10YR 2/2) moist; strong, fine, angular blocky structure; hard, firm, plastic and sticky; shiny ped faces and continuous clay films; many fine roots; about 55 percent, by volume, igneous rock fragments that consist of 25 percent gravel, 20 percent cobbles, and 10 percent stones; neutral; clear, smooth boundary.

B22t—6 to 16 inches, reddish-brown (5YR 5/3) gravelly clay, reddish brown (5YR 4/3) moist; strong, fine, angular blocky structure; hard, firm, plastic and sticky; shiny ped faces and continuous clay films; about 55 percent, by volume, igneous rock fragments that consist of 25 percent gravel, 20 percent cobbles, and 10 percent stones; slightly acid; abrupt, irregular boundary.

R1—16 to 24 inches, pale-olive, fractured igneous bedrock; weakly cemented; thin patchy films of lime in seams.

R2—24 to 30 inches, brown, coarsely fractured igneous bedrock; strongly cemented.

The solum ranges from 10 to 20 inches deep to weakly cemented igneous material. It is 35 to 80 percent, by volume, angular igneous rock fragments that are 15 to 50 percent gravel, 5 to 35 percent cobbles, and 0 to 25 percent stones.

The A horizon ranges from 3 to 9 inches in thickness. It is very dark grayish-brown, dark grayish-brown, or dark-brown stony, cobbly, or gravelly silt loam, loam, or sandy loam. The B2t horizon is 8 to 17 inches thick. It is very dark grayish brown, dark reddish gray, dark reddish brown, reddish brown, dark brown, or dark reddish brown. Reaction is neutral or slightly acid. This horizon ranges from 50 to 70 percent clay. The R horizon is igneous material that ranges from weakly cemented tuff and ash to strongly cemented basaltic, rhyolitic, and trachytic material. Depth to the R2 layer is 20 inches to several feet. In some places there are few to many soft masses of calcium carbonate in the lower part of the B2t horizon and the upper part of the R1 horizon.

Mainstay-Brewster association, hilly (MbE).—This association is on igneous hills. Slopes are mostly 10 to 30 percent, but some slopes are 5 to 10 percent. Areas are mainly 160 to 2,500 acres in size.

This association is 20 to 40 percent Mainstay soils, 10 to 40 percent Brewster soils, 10 to 30 percent Liv soils, and 10 to 30 percent other soils and Rock outcrop. Mainstay and Liv soils are on the lower side slopes of the hills, and Brewster soils are on the upper side slopes. The included soils are Boracho and Limpia on fans at the base of hills. Rock outcrop is at scarps and sharp breaks of slopes.

The Mainstay soil that has the profile described as representative of the Mainstay series is in this association.

Brewster soils have a surface layer of grayish-brown gravelly loam about 6 inches thick over fractured rhyolite bedrock.

The soils of this association are well drained. Available water capacity is low. Plants make effective use of light rainfall, but much of the water from heavy rainfall

runs off. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

These soils are used for range. Capability unit VIIs-3; Igneous Hill and Mountain range site.

Medley Series

The Medley series consists of deep, well-drained, noncalcareous loamy soils. These soils formed in loamy outwash material derived from igneous hills and mountains. They are on fans and low terraces in valleys of the Davis Mountains. Elevation is mainly 4,000 to 5,000 feet. The native vegetation is short and mid grasses and, in some places, an overstory of low shrubs.

In a representative profile the surface layer is grayish-brown, neutral gravelly sandy loam about 10 inches thick. The next layer is brown, friable, neutral gravelly loam about 14 inches thick. Below this, and extending to a depth of 65 inches or more, is brown, friable, calcareous loam that has many threads and films of lime.

Medley soils are used only for range. They are suited to pasture and irrigated crops.

Medley soils in Jeff Davis County are mapped only with Santo Tomas soils.

Representative profile of Medley gravelly sandy loam in an area of Santo Tomas-Medley association, gently sloping, 20.3 miles west of Fort Davis on Texas Highway 166, 200 feet south of highway, and 1.7 miles east on Texas Highway 166 from the junction of Farm Road 505:

A11—0 to 10 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many fine roots; 20 percent, by volume, igneous gravel; neutral; clear, smooth boundary.

A12—10 to 24 inches, brown (7.5YR 5/2) gravelly loam, dark brown (7.5YR 3/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; common fine roots; 20 percent, by volume, igneous gravel; neutral; clear, smooth boundary.

B2ca—24 to 58 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; moderate, fine, subangular blocky structure; slightly hard, friable; 13 percent, by volume, igneous gravel; many threads and films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—58 to 65 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; 15 percent, by volume, igneous gravel; many threads and films of lime; calcareous; moderately alkaline.

The solum is more than 40 inches thick. Depth to secondary calcium carbonate is 12 to 36 inches. The soil is loam, sandy loam, sandy clay loam, clay loam, and their gravelly analogs throughout. It ranges from 10 to 30 percent, by volume, coarse fragments that are 10 to 30 percent gravel and 0 to 5 percent cobbles or stones. The soil between depths of 10 and 40 inches ranges from 18 to 35 percent clay.

The A horizon ranges from 20 to 40 inches in thickness. It is grayish brown, dark grayish brown, brown, or reddish brown. Reaction is neutral to moderately alkaline. The B horizon is 18 to 45 inches thick. It is light brown, brown, or light reddish brown. The C horizon is brown, light brown, pink, light reddish brown, or pale brown.

Mitre Series

The Mitre series consists of shallow, well-drained, noncalcareous gravelly soils that are underlain by indurated caliche. These soils formed in very gravelly and stony outwash material derived from igneous rock. They are on fans and high terraces in

valleys and on plains. Elevation is mainly 4,000 to 5,000 feet. The native vegetation is short grasses.

In a representative profile the surface layer is reddish-brown gravelly loam about 4 inches thick. The next layer is reddish-brown very gravelly clay loam about 10 inches thick. Below this is pink caliche about 8 inches thick that is indurated in the upper 3 inches and strongly cemented below. The underlying material is pinkish-white caliche that is weakly cemented.

Permeability is moderate in these soils. Runoff is medium.

Mitre soils are used only for range.

Mitre soils in Jeff Davis County are mapped only with Limpia soils.

Representative profile of Mitre gravelly loam in a pasture in an area of Limpia and Mitre soils, gently sloping, 32 miles northwest of Fort Davis, 2 $^{1}/_{4}$ miles southeast on Cherry Creek county road from the junction of Interstate Highway 10, and 10 yards south of road:

A1—0 to 4 inches, reddish-brown (5YR 5/3) gravelly loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many roots; 20 percent, by volume, angular igneous rock fragments, mostly less than 1/4 inch to 1 inch in diameter; neutral; clear, smooth boundary.

B2t—4 to 14 inches, reddish-brown (5YR 4/3) very gravelly clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, subangular blocky structure; slightly hard, friable; many roots; 60 percent, by volume, angular igneous rock fragments; mostly $^{1}/_{2}$ inch to 3 inches in diameter; neutral; abrupt, smooth boundary.

Ccam—14 to 22 inches, pink (7.5YR 8/4) caliche; indurated and platy in upper 3 inches (plates ½ to 1 inch thick), strongly cemented in lower part; 80 percent, by volume, angular igneous rock fragments; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—22 to 40 inches, pinkish-white (7.5YR 8/2) caliche; weakly cemented; 80 percent, by volume, angular igneous rock fragments that consist of 50 percent gravel, 20 percent cobbles, and 10 percent stones; calcareous; moderately alkaline.

Depth to indurated caliche ranges from 11 to 20 inches.

The A and B2t horizons are reddish brown, reddish gray, brown, or dark reddish gray. Reaction is neutral or mildly alkaline. The A horizon is 3 to 7 inches thick. It is gravelly, very gravelly, or cobbly sandy loam, sandy clay loam, or loam. The B2t horizon ranges from 6 to 16 inches in thickness. It is gravelly, very gravelly, and cobbly clay loam, sandy clay, or clay that is 35 to 50 percent clay. It is 35 to 80 percent, by volume, igneous coarse fragments that are 20 to 50 percent gravel, 5 to 40 percent cobbles, and 0 to 20 percent stones. The Cca horizon is white, pinkish white, pink, or very pale brown. It is indurated or strongly cemented in the upper 4 to 40 inches and weakly cemented below.

Musquiz Series

The Musquiz series consists of deep, well-drained, noncalcareous loamy soils. These soils formed in loamy and clayey alluvial sediment derived from igneous rock. They are in valleys in the Davis Mountains. Elevation is mainly 4,500 to 5,500 feet. The native vegetation is mainly mid and tall grasses.

In a representative profile (fig. 16) the surface layer is reddish-gray, mildly alkaline loam about 7 inches thick. The next layer, to a depth of 30 inches, is clay that is reddish brown in the upper part and red in the lower part. The underlying material, which extends to a depth of 60 inches or more, is light reddish-brown clay loam in the upper part and light reddish-brown loam in the lower part.

Permeability is moderately slow in these soils. Runoff is medium.

Musquiz soils are used mainly for range. They are well suited to pasture and irrigated crops. They are poorly suited to dryland farming.

Representative profile of Musquiz loam in a pasture in an area of Musquiz association, 3 miles south of Fort Davis on Texas Highway 118, 200 feet west of highway, center of the west boundary of Sec. 8, Block 2, H&TC Ry. Co. Survey:

A1—0 to 7 inches, reddish-gray (5YR 5/2) loam, dark reddish brown (5YR 3/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable; few fine, igneous pebbles and quartz grains; mildly alkaline; clear, smooth boundary.

B21t—7 to 17 inches, reddish-brown (5YR 5/3) clay, dark reddish brown (5YR 3/3) moist; moderate, medium, blocky structure; very hard, firm; many fine, igneous pebbles and quartz fragments; few thin, patchy clay films; neutral; clear, smooth boundary.

B22t—17 to 30 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate, fine, blocky structure; hard, firm; distinct clay films on ped faces; many fine, igneous pebbles and quartz fragments; neutral; clear, wavy boundary.

Figure 16.—Profile of Musquiz loam. Note wavy boundary of the caliche layer, which is the caliche layer, which is the white layer in lower part of picture. This layer is about 30 inches below the soil surface.

Cca—30 to 40 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (5YR 5/4) moist; massive; hard, friable; about 15 percent, by volume, concretions and soft masses of calcium carbonate; about 15 percent rounded and angular fragments; calcareous; moderately alkaline; gradual, wavy boundary.

C—40 to 60 inches, light reddish-brown (5YR 6/4) loam, reddish brown (5YR 5/4) moist; massive; hard, friable; 5 percent, by volume, pebbles and concretions coated with calcium carbonate; about 5 percent angular rhyolite fragments; calcareous; moderately alkaline.

The solum ranges from 25 to 40 inches in thickness. Depth to the zone of secondary lime accumulation ranges from 24 to about 36 inches.

The A horizon ranges from 4 to 10 inches in thickness. It is reddish-gray, dark reddish-gray, reddish-brown, brown, grayish-brown, or dark grayish-brown loam or clay loam. The B21t horizon is clay loam or clay 6 to 10 inches thick. It is reddish brown or brown. The B22t horizon ranges from 6 to 18 inches in thickness. It is reddish brown, red, reddish yellow, or yellowish red. The upper 20 inches of the B2t horizon ranges from 35 to 55 percent clay. In some places there is a B3t horizon that is similar to the B22t horizon in color but is loam or clay loam that is 10 to 30 percent, by volume, igneous pebbles and fragments. The C horizon ranges from reddish-brown to light reddish-brown loam or clay loam that is 5 to 30 percent, by volume, igneous pebbles and fragments. The Cca horizon ranges from 6 to 20 inches in thickness. It has a calcium carbonate equivalent of 15 to 25 percent.

Musquiz association (Mu).—This association is on plains of valleys. Slopes are plane to slightly concave and range from 0 to 3 percent (fig. 17). Areas are broad and irregularly shaped. They range from 40 to 18,360 acres in size.

Figure 17.—Musquiz association in a nearly level area of an intermountain valley. The grass is mostly blue grama.

This association is 50 to 70 percent Musquiz soils, 10 to 30 percent soils that are similar to Musquiz soils but thicker, and 0 to 40 percent other soils. Musquiz soils are on nearly level plains. The soils similar to Musquiz soils are in drainageways and areas that generally receive extra water. In some areas they are transitional to the included Redona and Chispa soils. Included in mapping are areas of Redona, Chispa, Santo Tomas, Verhalen, and Reagan soils. Redona, Chispa, and Reagan soils are on low ridges. Santo Tomas soils are along narrow stream channels in some of the areas. Verhalen soils are in small depressions.

The Musquiz soil that has the profile described as representative for the series is in this association.

Available water capacity is high in the soils of this association. They have a friable surface layer and are easy to manage. Runoff is medium. The hazard of water erosion is slight to moderate. The hazard of soil blowing is slight. Unless the soils are protected by a cover of plants, surface crusting increases runoff and the hazard of erosion.

These soils are poorly suited to crops because of low rainfall in most years. Areas that receive additional water in the form of runoff or by water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit IVe-1; Deep Upland range site.

Nickel Series

The Nickel series consists of very shallow to shallow, well-drained, calcareous gravelly soils that are underlain by weakly cemented gravelly caliche. These soils formed in very gravelly outwash material. They are on ridges, fans, and terraces. The native vegetation is low shrubs.

In a representative profile (fig. 18) the surface layer is light brownish-gray and pale-brown gravelly loam about 7 inches thick that is about 40 percent, by volume, caliche-coated pebbles. The next layer is white, weakly cemented, fragmental gravelly caliche. The underlying material, which extends to a depth of 40 inches, is very pale brown very gravelly loam. Below this is pinkish-white limy clayey earth.

Permeability is moderately rapid in these soils. Runoff is medium.

Nickel soils are used only for range.

Representative profile of Nickel gravelly loam in an area of Nickel-Chispa association, undulating, 4 miles west of Valentine on a county road at a caliche pit on south side of road, Sec. 367, Block 4, H&TC Ry. Co. Survey:

A11—0 to 2 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, platy structure; soft, very friable; 20 percent, by volume, igneous and limestone pebbles, mostly less than 1 inch in diameter; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—2 to 7 inches, pale-brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; weak, fine, granular and subangular blocky structure; soft, friable; many roots; 40 percent, by volume, caliche-coated pebbles and fragments; calcareous; moderately alkaline; abrupt, smooth boundary.

Cca—7 to 29 inches, white (10YR 8/2) brittle, fragmental gravelly caliche; weakly cemented; about 40 percent, by volume, igneous and limestone pebbles; very pale brown (10YR 7/3) loam in pockets and partings; few roots; clear, smooth boundary.

C—29 to 40 inches, very pale brown (10YR 8/3) very gravelly loam; 65 percent, by volume, igneous and limestone pebbles, mostly less than 1 inch in diameter; calcareous; moderately alkaline; abrupt, clear boundary.

IIC—40 to 60 inches, pinkish-white (7.5YR 8/2) limy clayey earth.

Figure 18.—Profile of Nickel gravelly loam. Layer of weakly cemented gravelly caliche is near the surface.

The A horizon ranges from 5 to 15 inches in thickness. It is 15 to 25 percent clay. It is light brownish gray, pale brown, or light brown. The Cca horizon is white, brittle, fragmental gravelly caliche that ranges from 15 to 30 inches in thickness. It is 35 to 80 percent coarse fragments.

The Nickel soils in Jeff Davis County are outside the range of the Nickel series in that they are loam that is 15 to 25 percent clay in the fine earth and some profiles are 35 to 50 percent, by volume, coarse fragments. The Nickel series is typically sandy loam that is 50 to 80 percent, by volume, coarse fragments. These differences do not affect the use and management of the soil.

Nickel-Chispa association, undulating (NcC).—This association is on fans and ridges. Slopes are convex. They are mostly 1 to 8 percent, but some slopes are 0 to 1 percent. Areas are mainly 40 to 300 acres in size.

This association is 50 to 70 percent Nickel gravelly loam, 20 to 30 percent Chispa soils, and 0 to 20 percent other soils. Nickel soils are on the undulating tops of gravelly hills and ridges. Chispa soils are on the basal side slopes. Included in mapping are areas of Hodgins, Reagan, Redona, Ima, and Vado soils that make up as much as 20 percent of the mapped areas.

The Nickel soil in this association has the profile described as representative of the Nickel series.

Chispa soils have a surface layer of pale-brown loam about 6 inches thick. The next layer is light-brown sandy clay loam about 25 inches thick. The underlying material, which extends to a depth of 70 inches or more, is very pale brown sandy clay loam.

Available water capacity is low in the Nickel soils of this association and high in the Chispa soils. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

These soils are used mainly for range. Gravelly range site; Nickel soils in capability unit VIIs-1; Chispa soils in capability unit VIs-8.

Phantom Series

The Phantom series consists of deep, well-drained, calcareous loamy soils. These soils formed in clayey sediment. They are on drainage flats and flood plains in wide valleys. The native vegetation is mainly short grasses.

In a representative profile (fig. 19) the surface layer is grayish-brown, calcareous clay loam about 8 inches thick. The next layer is dark grayish-brown, firm, calcareous clay loam about 9 inches thick. Below this is dark grayish-brown, very firm, calcareous silty clay about 27 inches thick. This is underlain by grayish-brown, friable, calcareous clay loam about 16 inches thick.

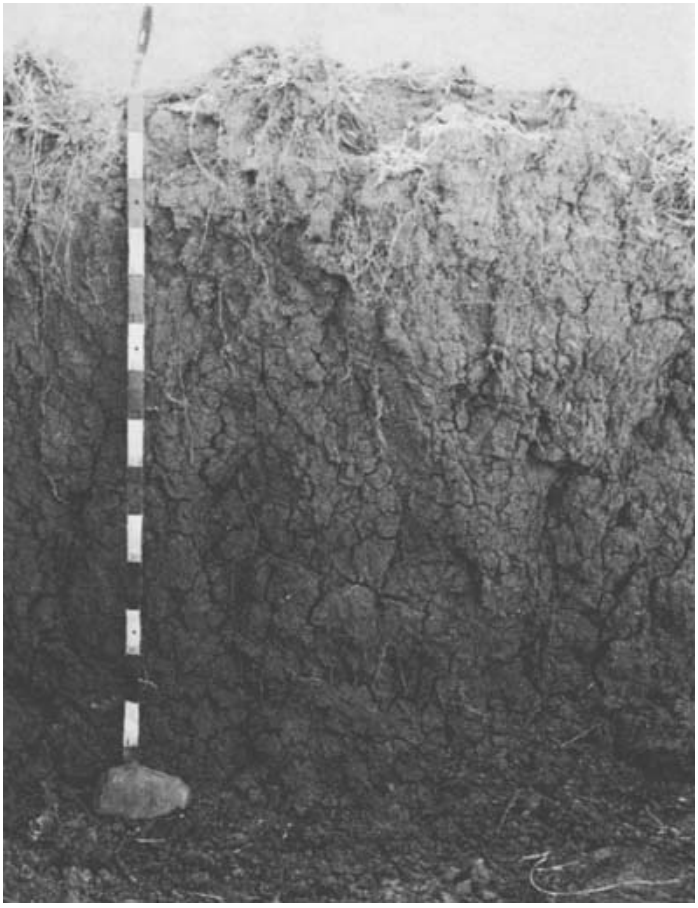

***Figure 19.*—Profile of Phantom clay loam. This dry soil has blocky structure.**

Permeability is moderately slow in these soils. Runoff is slow to medium.

Phantom soils are used mainly for range. They are suited to pasture and irrigated crops.

Representative profile of Phantom clay loam in a pasture in an area of Phantom association, 27.5 miles north of Fort Davis on Texas Highway 17 and 200 feet west of highway:

A11—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, platy and subangular blocky structure; slightly hard, friable; common fine roots; few cracks about $^1/_2$ inch wide; calcareous; moderately alkaline; abrupt, smooth boundary.

A12—8 to 17 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; strong, fine, angular blocky structure; hard, firm; common fine roots; few cracks about $^1/_2$ inch wide; calcareous; moderately alkaline; gradual, smooth boundary.

A13—17 to 44 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, blocky structure; very hard, very firm; few very fine, hard concretions of calcium carbonate; few roots; few cracks about 1 inch wide to a depth of at least 30 inches; calcareous; moderately alkaline; gradual, smooth boundary.

B2—44 to 60 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, blocky structure; slightly hard, friable; calcareous; moderately alkaline.

The solum ranges from 40 to 60 inches or more in thickness. Cracks $^1/_2$ to 1 inch wide range to a depth of 20 to 36 inches where the soil is dry. Reaction is neutral to moderately alkaline. Between depths of 10 and 40 inches the soil is 35 to 60 percent clay.

The A horizon ranges from 31 to 50 inches in thickness. It is grayish-brown, dark grayish-brown, or brown clay loam, silty clay, or clay. The B horizon is grayish-brown, light brownish-gray, pale-brown, or light-brown clay loam or clay that has a few pebbles, cobbles, and stones in some areas.

Phantom association (Ph).—This association is on arid flood plains, terraces, and flats. Slopes are 0 to 3 percent. Areas are 160 to 600 acres in size.

This association is 60 to 90 percent Phantom soils, 10 to 30 percent Hodgins soils, and 10 to 20 percent other soils. Included in mapping, in small areas of less than 5 acres on ridges and fans, are Santo Tomas, Dalby, and Medley soils.

Phantom soils have a surface layer of clay loam, silty clay, and clay but dominantly clay loam. They are 40 inches or more deep to bedrock.

The Phantom soil that has the profile described as representative for the series is in this association.

Available water capacity is high in the soils of this association. Most areas receive extra water that runs off from adjoining soils. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

These soils are unsuited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit VIc-1; Clay Flat range site.

Puerta Series

The Puerta series consists of shallow, well-drained, noncalcareous gravelly soils that are underlain by igneous bedrock. These soils formed in a stony mantle. They are on hills and mountains at the higher elevations of the Davis Mountains. Elevation

is mainly 6,000 to 7,500 feet. The native vegetation is mainly trees and some grasses.

In a representative profile the surface layer is dark grayish-brown, neutral gravelly silt loam about 5 inches thick. The next layer is light brownish-gray, friable, medium acid gravelly loam about 4 inches thick. Below this is brown, firm, strongly acid gravelly clay about 9 inches thick. Depth to fractured igneous bedrock is about 18 inches.

Permeability is moderate in these soils. Runoff is rapid.

Puerta soils are used mainly for range. They are suited to trees.

Representative profile of Puerta gravelly silt loam in an area of Puerta-Madrone association, steep, 11½ miles west of McDonald Observatory on Texas Highway 118 to junction of ranch road leading up Loghouse Canyon and 3 $^{1}/_{4}$ miles south on ranch road, at a cut on side of road:

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; soft, friable; many roots; 40 percent, by volume, igneous rock fragments that consist of 30 percent gravel and 10 percent cobbles; neutral; abrupt, smooth boundary.

A2—5 to 9 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; many roots; 40 percent, by volume, igneous rock fragments that consist of 30 percent gravel and 10 percent cobbles; medium acid; clear, irregular boundary.

B2t—9 to 18 inches, brown (7.5YR 5/2) gravelly clay, brown (7.5YR 4/2) moist; strong, medium, blocky structure; hard, firm, plastic and sticky; few roots; few distinct clay films; 50 percent, by volume, coarse igneous rock fragments that consist of 35 percent gravel and 15 percent cobbles; strongly acid; abrupt, broken boundary.

R—18 to 30 inches, grayish, fractured igneous bedrock; seams in rock filled with brown clay.

Depth to igneous bedrock ranges from 12 to 20 inches. The solum is 35 to 80 percent coarse fragments that are 20 to 50 percent gravel, 5 to 35 percent cobbles, and 0 to 25 percent stones. In places there are stones 10 to 24 inches in diameter.

The A1 horizon ranges from 4 to 6 inches in thickness. It is dark grayish-brown, grayish-brown, or brown gravelly, very gravelly, or cobbly loam, silt loam, or sandy loam. The A2 horizon is 1 inch to 7 inches thick. It is pinkish-gray, light brownish-gray, pale-brown, or light-gray gravelly, very gravelly, or cobbly loam or sandy loam. The B2t horizon ranges from 5 to 15 inches in thickness. It is brown, grayish-brown, or reddish-brown gravelly, very gravelly, or cobbly clay that ranges from 50 to 70 percent clay. The R horizon is extrusive igneous rock, mostly rhyolite and trachyte.

Puerta-Madrone association, steep (PmF).—This association is on igneous mountains. Slopes are mostly 20 to 45 percent. Areas are irregularly circular in shape and range from 40 to 20,400 acres in size.

This association is 30 to 50 percent Puerta soils, 20 to 40 percent Madrone soils, 10 to 30 percent other soils, and 5 to 10 percent Rock outcrop. Puerta and Madrone soils are mainly on the shady slopes of hills in a complex pattern. Included in mapping are areas of Brewster soils and soils that are similar to Brewster soils but underlain by soft igneous rocks. These included soils are near the top of mountains. Also included are areas of Mainstay and Liv soils, mainly on south-facing side slopes. Rock outcrop is included along sharp ledges and scarps, mostly near the top of mountains. Most areas of included soils are less than 1 acre in size.

The Puerta and Madrone soils in this association have the profile described as representative of their respective series.

The soils of this association are gravelly. Available water capacity is low in the Puerta soils and medium in the Madrone soils. The stones and organic litter retard water erosion. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

These soils are not suited to crops. They are used mainly for range. They support a forest or woodland cover of pines, junipers, and oaks (fig. 20). Capability unit VIIs-3; Mountain Loam range site.

Reagan Series

The Reagan series consists of deep, well-drained, calcareous loamy soils. These soils formed in loamy sediment. They are on plains and in valleys. The native vegetation is mainly short and mid grasses and low shrubs.

In a representative profile the surface layer is light brownish-gray clay loam about 4 inches thick. The next layer is pinkish-gray clay loam about 6 inches thick. Below this is pale-brown clay loam about 16 inches thick. The next layer is pink, calcareous clay loam that has a high calcium carbonate accumulation and is about 16 inches thick. This is underlain by light-brown, calcareous clay loam about 28 inches thick.

Permeability is moderate in these soils. Runoff is slow to medium.

Reagan soils are used mainly for range. A few areas are used for irrigated crops and pasture.

Representative profile of Reagan clay loam in a pasture in an area of Reagan-Hodgins association, 3 $^{1}/_{2}$ miles north of Valentine on county road and .2 mile west:

A11—0 to 4 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, fine, platy and subangular blocky structure;

Figure 20.—Puerta-Madrone association, steep. These soils are at higher elevations on the Davis Mountains.

slightly hard, friable, plastic and sticky; many roots; calcareous; moderately alkaline; clear, smooth boundary.

A12—4 to 10 inches, pinkish-gray (7.5YR 6/2) clay loam, brown (7.5YR 4/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable, plastic and sticky; many roots; calcareous; moderately alkaline; clear, smooth boundary.

B21—10 to 26 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak, fine and medium, subangular blocky structure; slightly hard, friable, plastic and sticky; many fine masses of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B22ca—26 to 42 inches, pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, plastic and sticky; 50 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B23ca—42 to 70 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; many fine soft masses of lime; calcareous; moderately alkaline.

The soil ranges from 24 to 38 inches deep to calcium carbonate. Between depths of 10 and 40 inches the soil is 25 to 35 percent clay, of which less than 15 percent is coarser than very fine sand.

The A horizon ranges from 8 to 12 inches in thickness. It is pinkish-gray, light brownish-gray, or pale-brown loam or clay loam. The B21 horizon is 10 to 24 inches thick. It is pinkish gray, light brown, pink, light brownish gray, light gray, pale brown, very pale brown, or light yellowish brown. The B22ca horizon ranges from 12 to 30 inches in thickness and generally is one value higher than the B21 horizon. It is 20 to 60 percent, by volume, soft and hard masses of calcium carbonate.

Reagan-Hodgins association (Rd).—This association is on plains. Slopes are plane and range from 0 to 3 percent. Areas are mainly 100 to 1,000 acres in size.

This association is 0 to 50 percent Reagan soils, 10 to 50 percent Hodgins soils, and 30 to 50 percent other soils. Reagan and Hodgins soils are nearly level to gently sloping. Included in mapping are areas of Chispa, Upton, Dalby, and Redona soils. Chispa and Upton soils are on undulating, low, narrow ridges. Dalby soils are in small depressions. In some places Reagan and Hodgins soils are transitional to Redona soils and include as much as 40 percent Redona soils. A few small areas are included in which there are no Reagan soils.

The Reagan and Hodgins soils in this association have the profiles described as representative of their respective series.

Available water capacity is high in the soils of this association. They are friable and easy to manage. Unless the soils are protected by a cover of plants, surface crusting increases runoff and the hazard of erosion. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

These soils are generally unsuited to crops because of low rainfall. Areas that receive additional water by runoff or water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit IVc-1; Deep Upland range site.

Redona Series

The Redona series consists of deep, well-drained loamy soils. These soils formed in loamy alluvial sediment derived mostly from igneous rock. They are on plains and in valleys. The native vegetation is mainly short and mid grasses and a few low shrubs in places.

In a representative profile (fig. 21) the surface layer is reddish-brown, neutral sandy loam about 6 inches thick. The next layer is reddish-brown, friable, mildly alkaline sandy clay loam about 16 inches thick. Below this is light-brown, friable, calcareous clay loam about 24 inches thick that is about 30 percent, by volume, soft and hard, segregated calcium carbonate. The next layer, which extends to a depth of 80 inches, is light-brown loam in the upper part and light-brown very gravelly sand in the lower part.

Permeability is moderate in these soils. Runoff is slow to medium.

Redona soils are used mainly for range. A few areas are used for irrigated crops and pasture.

Representative profile of Redona sandy loam in a pasture in an area of Redona association, 1 mile north of Valentine on county road and 250 yards east of road:

A1—0 to 6 inches, reddish-brown (5YR 5/3) sandy loam, reddish brown (5YR 4/3) moist; moderate, fine, platy and subangular blocky structure; hard, friable, sticky and plastic; many fine roots; few igneous pebbles; neutral; abrupt, smooth boundary.

B2t—6 to 22 inches, reddish-brown (5YR 5/3) sandy clay loam, reddish brown (5YR 4/3) moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; many fine roots; few thin clay films; few igneous pebbles; mildly alkaline; clear, smooth boundary.

B2tca—22 to 44 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak, fine, subangular blocky structure; hard, friable, sticky and

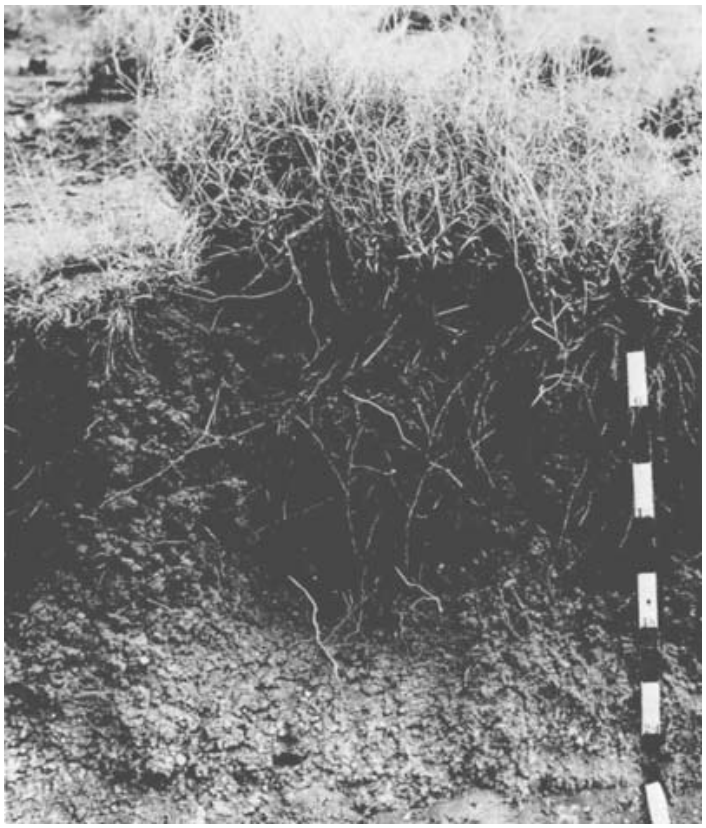

Figure 21.—Profile of Redona sandy loam. A layer of soft masses of calcium carbonate is at a depth of about 22 inches.

plastic; few thin clay films; 30 percent, by volume, soft and hard segregations of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—44 to 66 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) moist; massive; hard, friable, sticky and plastic; few igneous pebbles; soft masses of lime; calcareous; moderately alkaline; clear, smooth boundary.

C—66 to 80 inches, light-brown (7.5YR 6/4) very gravelly sand, brown (7.5YR 5/4) moist; single grained; loose; 50 percent, by volume, igneous pebbles; few soft masses of lime; calcareous; moderately alkaline.

The solum ranges from 40 to 70 inches in thickness. Depth to the zone of calcium carbonate accumulation ranges from 20 to 50 inches.

The A horizon ranges from 6 to 12 inches in thickness. It is reddish-brown or brown sandy loam, sandy clay loam, or loam. Reaction is neutral to mildly alkaline. The B2t horizon is light reddish-brown, reddish-brown, brown, or light-brown sandy clay loam or clay loam. The upper part of the B2t horizon is neutral to mildly alkaline and ranges from 15 to 22 inches thick. The lower part is moderately alkaline; is 15 to 50 percent, by volume, segregates of calcium carbonate; and ranges from 10 to 40 inches in thickness. The Cca horizon is 0 to 20 inches thick. It is light-brown or pink loam, sandy clay loam, or clay loam. The C horizon is light-brown or pink loam, loamy sand, sand, or clay loam that ranges from 10 to 60 percent igneous gravel.

A part of the Redona soils in Jeff Davis County are outside the range of the Redona series in that the depth to the upper boundary of the calcic material ranges from 20 to 50 inches. The Redona series typically is 40 inches deep to calcic material. This difference does not affect the use and management of the soils.

Redona association (Re).—This association is on plains. Slopes are plane to convex and range from 0 to 3 percent. Areas are mainly 100 to 1,000 acres in size.

This association is 40 to 80 percent Redona soils and 20 to 60 percent other soils. Included in mapping are areas of Dalby, Reagan, and Verhalen soils that make up as much as 20 percent of the mapping unit. Where the Redona soils are transitional to the Musquiz soils, some of the lower areas are as much as 40 percent Musquiz soils and receive extra water. Also included are a few areas of soils that are similar to Redona soils but do not have a layer of calcium carbonate within 40 inches of the surface and are sandier. These included soils are on ridges and terraces and make up as much as 30 percent of the mapped areas.

The Redona soil that has the profile described as representative for the series is in this association.

Available water capacity is high in the soils of this association. Unless the soils are protected by a cover of plants, surface crusting increases runoff and the hazard of erosion. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

These soils are unsuited to crops because of low rainfall. They are used mainly for range. Capability unit IVc-1; Deep Upland range site.

Rockhouse Series

The Rockhouse series consists of deep, well-drained, noncalcareous loamy soils. These soils formed in very gravelly and cobbly alluvium derived from igneous rock. They are on flood plains in high-gradient streams in the Davis Mountains. Elevation is mainly 4,000 to 5,000 feet. The native vegetation is a moderate cover of mid and short grasses and low shrubs.

In a representative profile (fig. 22) the surface layer is dark grayish-brown, neutral loam about 12 inches thick that has few gravel, cobbles, and stones. The next layer, about 48 inches thick, is grayish brown. It is neutral very cobbly loamy sand in the

Figure 22.—Profile of Rockhouse loam has a large amount of cobbles and gravel in the lower layers.

upper part and very cobbly sand in the lower part and is about 70 percent, by volume, igneous gravel, cobbles, and stones.

Permeability is rapid in these soils. The soils are occasionally flooded in summer.

Rockhouse soils are used mainly for range. A few areas are used for pasture and irrigated crops.

Representative profile of Rockhouse loam in an area of Rockhouse association, about 20 miles northeast of Fort Davis on Texas Highway 17 to junction of Farm Road 1830 and .1 mile northwest of junction in Rockhouse Canyon:

A1—0 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; many roots; many fine pores; few subrounded igneous gravel, cobbles, and stones; neutral; clear, smooth boundary.

C1—12 to 20 inches, grayish-brown (10YR 5/2) very cobbly loamy sand, very dark grayish brown (10YR 3/2) moist; single grained; few roots; 70 percent, by volume, subrounded igneous rock fragments that consist of 30 percent gravel, 30 percent cobbles, and 10 percent stones; neutral; diffuse, wavy boundary.

C2—20 to 60 inches, grayish-brown (10YR 5/2) very cobbly sand, very dark grayish brown (10YR 3/2) moist; single grained; few roots; 70 percent, by volume, subrounded igneous rock fragments that consist of 30 percent gravel, 30 percent cobbles, and 10 percent stones; neutral.

The A and C horizons are more than 60 inches deep to underlying bedrock.

The A horizon ranges from 6 to 16 inches in thickness. It is dark grayish-brown, grayish-brown, or brown sandy loam, loam, or silt loam that in places is gravelly and cobbly. It ranges from 5 to 40 percent, by volume, coarse fragments that are 5 to 40

percent gravel, 2 to 20 percent cobbles, and 0 to 10 percent stones. Reaction ranges from slightly acid to mildly alkaline. The C horizon is grayish-brown or brown loamy sand that is 35 to 80 percent, by volume, coarse fragments that are 20 to 50 percent gravel, 10 to 40 percent cobbles, and 0 to 25 percent stones. Reaction ranges from neutral to moderately alkaline. In some places a few carbonates occur as faint films or coatings on the coarse fragments.

Rockhouse association (Rh).—This association is on flood plains. Slopes are mostly less than 1 percent. Areas are long and narrow and follow intermittent streams. They are mainly 100 to 1,000 acres in size.

This association is 70 to 100 percent Rockhouse soils and 0 to 30 percent Gageby soils. The Rockhouse soils have very gravelly and cobbly underlying material, but the Gageby soils do not. Included in mapping are small areas of Phantom, Santo Tomas, and Limpia soils on low fans and terraces. These included soils make up less than 15 percent of the mapping unit. Gravelly and stony stream-washed material is in stream channels. This material is mainly igneous pebbles and stones. It supports little or no vegetation.

The Rockhouse soil that has the profile described as representative of the Rockhouse series is in this association.

The soils in this association are well drained. Available water capacity is low. The soils receive water from adjoining areas and are occasionally flooded. Unless they are protected by a cover of grass, the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rockhouse soils in this association are unsuited to crops because of low rainfall and stones. Areas that receive additional water by drainage or water spreading are suited to pasture. Under good management, successful pasture and hay crops can be established and maintained. Capability unit VIs-2; Draw range site.

Rockhouse-Gageby association (Rk).—This association is on flood plains. Slopes are mostly less than 1 percent. Areas are long and narrow and follow intermittent streams. They are mainly 100 to 1,000 acres in size.

This association is 33 to 80 percent Rockhouse soils, 10 to 40 percent Gageby soils, 5 to 20 percent gravelly and stony stream-washed material, and 5 to 30 percent other soils. All areas have a stream channel 40 to 120 feet wide that is mostly igneous gravel and stone.

Rockhouse soils have a surface layer of grayish-brown sandy loam about 15 inches thick. The next layer, which extends to a depth of 60 inches or more, is brown very gravelly loamy sand.

Gageby soils have a dark grayish-brown surface layer about 48 inches thick. It is silt loam in the upper part and clay loam in the lower part. The next layer is grayish-brown clay loam about 10 inches thick. The underlying material, which extends to a depth of 68 inches or more, is brown loam.

Available water capacity is low in the Rockhouse soils of this association and high in the Gageby soils.

These soils are not well suited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Draw range site; Rockhouse soils in capability unit VIs-2; Gageby soils in capability unit Vw-1.

Rock Outcrop

Rock outcrop consists mostly of igneous rock masses and rubble piles on rock masses, hills, peaks, scarps, and canyon walls of the Davis Mountains. Slopes are mostly 20 to 45 percent. Elevation is mainly 5,000 to 6,000 feet. The native vegetation is a sparse cover of mostly growths in fractures between rocks and in areas of minor soils.

Areas of Rock outcrop are used mostly for range.

Rock outcrop-Brewster association, steep (RoF).—This association is on hills, peaks, scarps, canyon walls, and bluffs that are mainly rock surfaces (fig. 23). Slopes are 20 to 45 percent. Areas are irregular in shape and range from 40 to 12,640 acres in size.

This association is 50 to 90 percent igneous Rock outcrop, 10 to 40 percent Brewster soils, and 0 to 20 percent other soils. Included in mapping are small areas, less than 5 acres in size, of Kokernot, Liv, and Mainstay soils on the top and sides of hills. Also included are small areas of Santo Tomas and Boracho soils at the base of these hills.

Areas of Rock outcrop are rough and have many large boulders several feet across.

Brewster soils have a surface layer of brown gravelly loam about 5 inches thick over fractured bedrock.

The soils of this association are steep and rocky. Runoff is rapid. Rock outcrop yields water to other soils, making light rainfall effective, but because of the shallow depth of the soils, much of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe.

These soils are too steep and too stony for pasture and crops. They are used only for range and as wildlife habitat. The native vegetation is a large variety of grasses, forbs, and woody plants. Capability unit VIIs-3; Igneous Hill and Mountain range site.

Figure 23.—Rock outcrop-Brewster association, steep. The Brewster soil is mostly on less steep places between areas of Rock outcrop.

Sanderson Series

The Sanderson series consists of deep, well-drained, calcareous gravelly soils. These soils formed in gravelly outwash material derived from limestone hills. They are on fans and ridges. The native vegetation is short grasses and shrubs.

In a representative profile (fig. 24) the surface layer is light brownish-gray, calcareous gravelly loam about 10 inches thick. The next layer is brown, friable, calcareous gravelly loam about 16 inches thick. Below this, and extending to a depth of 50 inches or more, is light-brown, loose, calcareous gravelly loam that has many threads and films of lime.

Permeability is moderate in these soils. Runoff is medium.

Sanderson soils are used only for range. They are poorly suited to pasture and irrigated crops.

Representative profile of Sanderson gravelly loam in a gravel pit in an area of Sanderson-Upton association, undulating, 26 miles north and slightly west of Fort Davis and 3 miles south on county road near Casey Draw from the junction with U.S. Highway 290, on the east side of the road:

A1—0 to 10 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; many roots; 20 percent, by volume, pitted limestone gravel; calcareous; moderately alkaline; clear, smooth boundary.

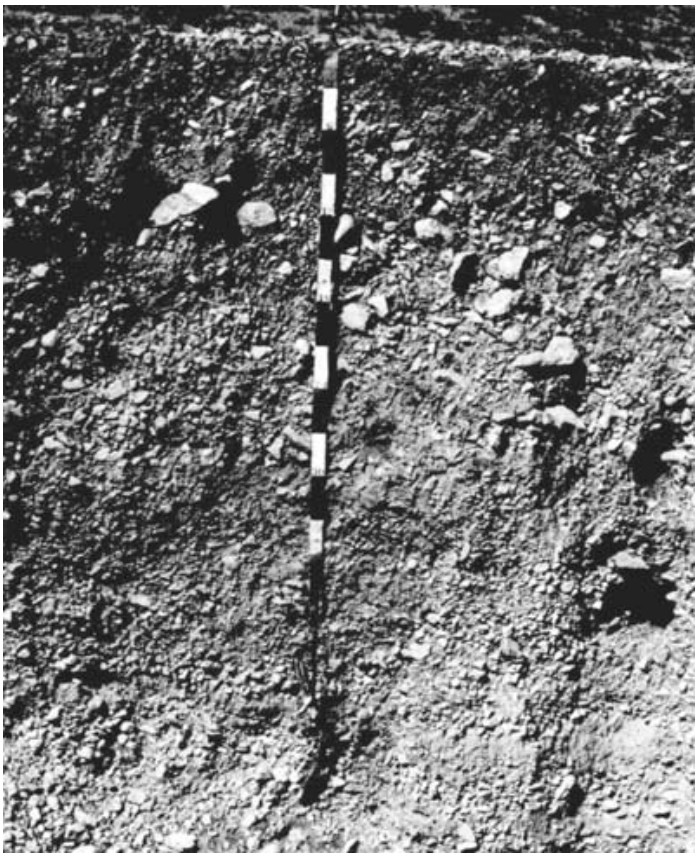

Figure 24.—Profile of Sanderson gravelly loam. Gravel content increases with depth in this soil.

B2—10 to 26 inches, brown (10YR 5/3) gravelly loam, brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; common roots; 40 percent, by volume, pitted limestone gravel; fine threads and films of lime; calcareous; moderately alkaline; gradual, smooth boundary.

C—26 to 50 inches, light-brown (7.5YR 6/4) gravelly loam, brown (7.5YR 5/4) moist; weak, fine, subangular blocky structure; loose; few roots; 40 percent, by volume, limestone gravel; many threads and films of lime; calcareous; moderately alkaline.

Between depths of 10 and 40 inches the soil ranges from 35 to 70 percent, by volume, coarse fragments that are 30 to 70 percent gravel, 0 to 20 percent cobbles, and 0 to 20 percent stones.

The A horizon ranges from 5 to 21 inches in thickness. It is light brownish-gray, grayish-brown, or pale-brown loam or clay loam. It is 15 to 45 percent, by volume, coarse fragments that are 15 to 40 percent gravel, 0 to 20 percent cobbles, and 0 to 10 percent stones. The B horizon is 10 to 20 inches thick. It is pale brown, light brown, or brown and ranges from 18 to 35 percent clay. The C horizon is light-brown or very pale brown very gravelly loam or clay loam. It ranges from 35 to 65 percent, by volume, coarse fragments that are 30 to 65 percent gravel, 0 to 20 percent cobbles, and 0 to 20 percent stones. It ranges from a few to 5 percent visible segregated calcium carbonate in the form of threads, films, and soft masses.

Sanderson-Upton association, undulating (SeC).—This association is on fans. Slopes are convex and range from 1 to 5 percent (fig. 25). Areas are irregularly oblong in shape and range from 100 to 600 acres in size.

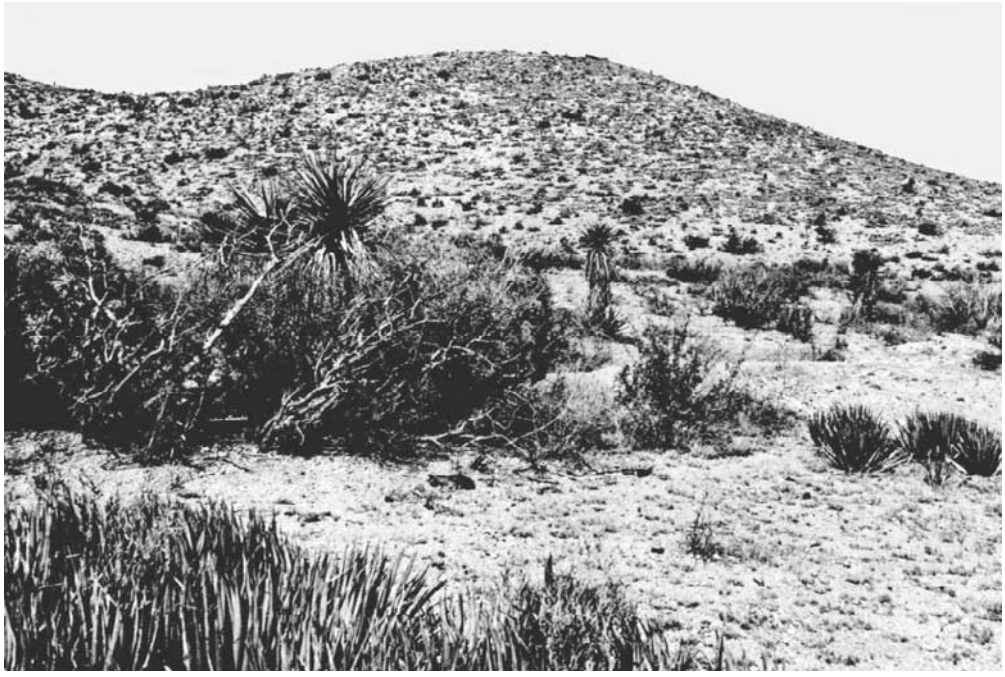

Figure 25.—Sanderson-Upton association, undulating, is on fans in the foreground. These soils are generally on fans that extend from limestone hills. Ector association, hilly, is on hill in the background.

This association is 30 to 70 percent Sanderson gravelly loam, 20 to 40 percent Upton gravelly loam, and 10 to 40 percent other soils. Upton soils are on the higher, older, sloping fans next to bases of hills. Sanderson soils are on the younger surfaces of fans on the side slopes away from hills. Included in mapping are areas of Hodgins and Reagan soils in drainageways and at the outer toe of the unit.

The Sanderson and Upton soils in this association each have the profile described as representative of their respective series.

The Sanderson soils of this association are deep, and the Upton soils are shallow to very shallow to indurated caliche. Available water capacity is medium in the Sanderson soils and low in the Upton soils. Runoff is medium. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

These soils are used mainly for range. Gravelly range site; Sanderson soils in capability unit VIs-3; Upton soils in capability unit VIIs-2.

Santo Tomas Series

The Santo Tomas series consists of deep, well-drained very gravelly soils. These soils formed in gravelly outwash material derived from igneous hills and mountains. They are on fans and ridges. Elevation is mainly 4,000 to 5,000 feet. The native vegetation is short and mid grasses and, in some places, low shrubs.

In a representative profile the surface layer is reddish-brown, neutral very gravelly loam about 24 inches thick that is about 50 percent, by volume, igneous gravel. The next layer is brown, friable, calcareous very gravelly loam about 36 inches thick that is about 80 percent, by volume, lime-coated igneous gravel. This is underlain by brown, massive, calcareous gravelly loam, about 15 inches thick, that is 35 percent igneous gravel and has a few films of lime.

Permeability is moderate in these soils. Runoff is medium.

Santo Tomas soils are used mostly for range. They are poorly suited to pasture and irrigated crops.

Representative profile of Santo Tomas-Medley association, gently sloping, about 31 miles northwest of Fort Davis, 7.5 miles south of county line on Texas Highway 118, and 100 feet west of highway:

A11—0 to 10 inches, reddish-brown (5YR 5/3) very gravelly loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many roots; 50 percent, by volume, igneous gravel; neutral; clear, smooth boundary.

A12—10 to 24 inches, reddish-brown (5YR 5/3) very gravelly loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; many roots; 50 percent, by volume, igneous gravel; neutral; clear, smooth boundary.

B2ca—24 to 60 inches, brown (7.5YR 5/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; few roots; 80 percent, by volume, igneous gravel; few soft masses of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

C—60 to 75 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/4) moist; massive; 35 percent, by volume, igneous gravel; few films and specks of lime; calcareous; moderately alkaline.

Depth to secondary lime accumulation ranges from 12 to 40 inches. Between depths of 10 and 40 inches the soil ranges from 18 to 35 percent clay and is 35 to 80 percent, by volume, coarse fragments that are 35 to 80 percent gravel, 0 to 25 percent cobbles, and 0 to 10 percent stones.

The A horizon ranges from 20 to 30 inches in thickness. It is grayish-brown, dark grayish-brown, brown, or reddish-brown very gravelly loam, sandy loam, sandy clay

loam, and clay loam. Reaction is neutral to moderately alkaline. The B horizon is 10 to 40 inches thick. It is grayish-brown, brown, or reddish-brown very gravelly loam, sandy loam, sandy clay loam, or clay loam. The C horizon is brown, light-brown, pink, light reddish-brown, or pale-brown gravelly and very gravelly loam or sandy loam. Reaction ranges from mildly alkaline to moderately alkaline.

Santo Tomas-Medley association, gently sloping (SmB).—This association is on fans. Slopes are convex and range from 1 to 5 percent. Areas are irregular lance shapes to oblong. They are mainly 100 to 600 acres in size. Most mapped areas are along foot slopes of igneous hills.

This association is 20 to 60 percent Santo Tomas gravelly loam, 30 to 70 percent Medley loam, and 10 to 40 percent other soils. Santo Tomas soils are on fans next to hills and on the outer edge of the mapped areas. Medley soils are in drainageways and on low terraces of streams. Included in mapping are areas of Boracho, Espy, Limpia, Brewster, and Volco soils. Boracho and Limpia soils are on higher fans next to hills. Small circular areas, less than 5 acres in size, of Brewster and Volco soils are on low hills in some mapped areas.

Santo Tomas soils are more than 35 percent coarse fragments, and Medley soils are less than 35 percent coarse fragments.

The Santo Tomas and Medley soils in this association each have the profile described as representative of their respective series.

Available water capacity is medium in the Santo Tomas soils and high in the Medley soils. Runoff is medium. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

These soils are used mainly for range. Areas that received additional water by drainage or by water spreading are suited to pasture. Capability unit VIs-4; Gravelly range site.

Sproul Series

The Sproul series consists of moderately deep, well-drained, noncalcareous loamy soils that are underlain by igneous bedrock. These soils formed in loamy material. They are on divides and tablelands of the higher areas of the Davis Mountains. Elevation is 5,000 to 6,250 feet. The native vegetation is mainly mid to tall grasses and scattered low shrubs and trees.

In a representative profile the surface layer is dark grayish-brown, slightly acid clay loam about 6 inches thick. The next layer is dark grayish-brown, very firm, slightly acid clay about 11 inches thick. Below this is brown clay about 9 inches thick. Depth to strongly cemented tuffaceous bedrock is about 26 inches. Permeability is slow in these soils. Runoff is slow to medium.

Sproul soils are used only for range.

Representative profile of Sproul clay loam in a pasture in an area of Sproul-Mainstay association, gently sloping, 3½ miles east and 1½ miles north of McDonald Observatory:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; common roots; about 5 percent, by volume, igneous pebbles as much as 3 inches in diameter; surface has many igneous pebbles, mainly $^{1}/_{2}$ inch to 2 inches in diameter; slightly acid; abrupt, wavy boundary.

B21t—6 to 17 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine iron-manganese accretions; few nonintersecting slickensides; few very dark

brown coatings on peds; shiny ped faces; few igneous pebbles; common roots; slightly acid; gradual, wavy boundary.

B22t—17 to 26 inches brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate, medium, angular blocky structure; few nonintersecting slickensides; extremely hard, very firm, very sticky and very plastic; few roots; few very dark brown coatings on peds; few weakly cemented iron-manganese accretions; about 5 percent, by volume, igneous pebbles and cobbles; slightly acid, abrupt, irregular boundary.

C—26 to 38 inches, light-gray (5Y 7/2) fractured, strongly cemented tuffaceous bedrock in 1- to 3-inch layers, light olive gray (5Y 6/2) moist; hardness of 1 to 1.5 on Moh's scale; patchy, dark-brown clay coatings on fragments; few fine roots in crevices.

The solum ranges from 21 to 40 inches deep to tuffaceous bedrock. It contains a few to about 15 percent, by volume, coarse fragments that generally increase with depth.

The A horizon ranges from 3 to 9 inches in thickness. It is dark grayish-brown, very dark grayish-brown, or dark-brown clay loam, silty clay loam, or silty clay. Reaction is neutral or slightly acid. The B2t horizon is 13 to 30 inches thick. It is the same color as the A horizon. It is clay that ranges from 60 to 75 percent clay. Reaction is neutral or slightly acid.

Sproul-Mainstay association, gently sloping (SnB).—This association is on mesas. Slopes are mainly 1 to 5 percent (fig. 26). Areas are oblong in shape and range from 40 to 1,560 acres in size.

This association is 50 to 70 percent Sproul soils, 20 to 40 percent Mainstay soils, and 10 to 20 percent other soils.

Figure 26.—Sproul-Mainstay association, gently sloping, on divides and mesas of igneous mountains.

Sproul soils are in the slightly depressed central part of the divides. Mainstay soils are on the more sloping, stony areas on the outer edge and low hills. Included in mapping are areas of Brewster, Kokernot, and Liv soils that occur with the Mainstay soils.

Sproul soils are more than 20 inches deep. The Sproul soil that has the profile described as representative of the series is in this association.

Mainstay soils have a surface layer of dark-brown cobbly loam about 8 inches thick. The next layer is dark-brown very gravelly clay about 10 inches thick. The underlying material is fractured bedrock.

Available water capacity is medium in the Sproul soils of this association and low in the Mainstay soils. The hazard of water erosion is moderate. The hazard of soil blowing is slight.

These soils are used only for range. Sproul soils in capability unit VIs-5; Igneous Divide range site. Mainstay soils in capability unit VIIs-3; Igneous Hill and Mountain range site.

Upton Series

The Upton series consists of shallow to very shallow, well-drained, calcareous gravelly soils that are underlain by hard caliche. These soils formed in gravelly outwash material derived from limestone. They are on fans that extend from limestone hills. Elevation is mainly 3,500 to 4,500 feet. The native vegetation is short grasses and low shrubs.

In a representative profile the surface layer is light brownish-gray gravelly loam about 4 inches thick. The next layer is pale-brown gravelly loam about 10 inches thick. This is underlain by hard caliche that is indurated in the upper inch and weakly cemented below.

Permeability is moderate in these soils. Runoff is medium.

Upton soils are used only for range.

Upton soils in Jeff Davis County are mapped only with Sanderson soils.

Representative profile of Upton gravelly loam in a pasture in an area of Sanderson-Upton association, undulating, about 26 miles north of Fort Davis, 2 miles southeast on U.S. Highway 290 from the junction of county road leading up Cherry Canyon, and 100 feet north of highway:

A1—0 to 4 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, platy and subangular blocky structure; slightly hard, friable; 15 percent, by volume, caliche and limestone fragments, mostly less than 1 inch in diameter; calcareous; moderately alkaline; clear, smooth boundary.

B2—4 to 14 inches, pale-brown (10YR 6/3) gravelly loam, brown (10YR 5/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; 25 percent, by volume, caliche and limestone fragments, mostly less than 1 inch in diameter; calcareous; moderately alkaline; abrupt, smooth boundary.

Ccam—14 to 20 inches, hard whitish caliche; upper 1 inch in indurated, cementation becomes less with depth; embedded limestone fragments; clear, smooth boundary.

Cca—20 to 46 inches, white (10YR 8/2) weakly cemented caliche, very pale brown (10YR 7/3) moist; pebbles and cobbles.

The soil ranges from 8 to 20 inches deep to indurated caliche.

The A1 and B2 horizons range from 15 to 35 percent, by volume, coarse fragments, mainly caliche and limestone. They are grayish-brown, light brownish-gray, brown, or pale-brown gravelly sandy loam, loam, or clay loam that ranges from 15 to 35 percent clay. The A horizon ranges from 4 to 6 inches thick. The B2 horizon

is 6 to 14 inches thick. The Ccam horizon ranges from 2 to 36 inches in thickness. The Cca horizon is weakly cemented or loose gravelly and stony material.

Vado Series

The Vado series consists of deep, well-drained, calcareous gravelly soils. These soils formed in gravelly outwash material derived from igneous hills. They are on fans and ridges. The native vegetation is short grasses and shrubs.

In a representative profile the surface layer is reddish-brown, calcareous gravelly sandy loam about 6 inches thick. The next layer is reddish-brown, friable, calcareous very gravelly sandy loam about 8 inches thick. The next layer is reddish-brown, calcareous gravelly sandy loam about 10 inches thick. The underlying material, which extends to a depth of 60 inches or more, is light reddish-brown very gravelly sandy loam.

Permeability is moderately rapid in these soils. Runoff is medium.

Vado soils are used only for range. They are poorly suited to pasture and irrigated crops.

Representative profile of Vado gravelly sandy loam in an area of Vado-Redona association, undulating, about 18 miles northwest of Valentine, 3.5 miles west on Farm Road 2017 from the junction with U.S. Highway 90, 2 miles south on ranch road, and 50 yards west of road, in the center of Sec. 69, Block 5, H&TC Ry. Co. Survey:

A1—0 to 6 inches, reddish-brown (5YR 5/3) gravelly sandy loam, dark reddish brown (5YR 3/3) moist; weak, fine, platy and subangular blocky structure; hard, friable; many roots; 15 percent, by volume, igneous gravel; calcareous; moderately alkaline; clear, smooth boundary.

B21—6 to 14 inches, reddish-brown (5YR 5/3) very gravelly sandy loam, reddish brown (5YR 4/3) moist; hard, friable; many roots; 55 percent, by volume, igneous gravel; patchy lime coatings on gravel; calcareous; moderately alkaline; clear, smooth boundary.

B22—14 to 24 inches, reddish-brown (5YR 5/3) gravelly sandy loam, reddish brown (5YR 4/3) moist; weak, fine, granular structure; hard, friable; common roots; 50 percent, by volume, igneous gravel; coatings of lime on gravel, few threads and films of lime; calcareous; moderately alkaline; clear, smooth boundary.

C—24 to 60 inches, light reddish-brown (5YR 6/3) very gravelly sandy loam, reddish brown (5YR 4/3) moist; massive; loose, very friable; few roots; 65 percent, by volume, igneous gravel; few patchy films of lime on gravel; calcareous; moderately alkaline.

The solum ranges from 12 to 40 inches in thickness. Between depths of 10 and 40 inches the soil is 35 to 80 percent, by volume, coarse fragments that are 30 to 80 percent gravel, 0 to 30 percent cobbles, and 0 to 15 percent stones.

The A and B horizons are reddish brown, brown, light brownish gray, or pinkish gray. The A horizon is 2 to 7 inches thick and is 10 to 65 percent, by volume, coarse fragments. The B horizon is 10 to 33 inches thick. The C horizon is light reddish brown, light brown, pale brown, or very pale brown. It is 35 to 80 percent, by volume, coarse fragments.

Vado-Redona association, undulating (VdC).—This association is on gravelly fans. Slopes are convex and range from 1 to 5 percent. Areas are mainly 100 to 500 acres in size.

This association is 50 to 80 percent Vado soils, 10 to 40 percent Redona soils, and 10 to 40 percent other soils. Vado soils are on the upper part of the fan next to

the slopes of hills. Redona soils are on the lower part of the fans next to the plains. Included in mapping are areas of Hodgins, Reagan, Chispa, and Dalby soils.

Vado soils are very gravelly, but Redona soils are not. Redona soils have a surface layer of reddish-brown sandy loam about 12 inches thick. The next layer is reddish-brown clay loam about 20 inches thick. This is underlain to a depth of 65 inches or more by light-brown loam.

The Vado soil that has the profile described as representative of the series is in this association.

Available water capacity is low in the Vado soils of this association and high in the Redona soils. Permeability is rapid. Runoff is medium because of slope. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

These soils are used mainly for range. They are poorly suited to irrigated crops and pasture. Vado soils in capability unit VIs-3; Gravelly range site. Redona soils in capability unit IVe-2; Deep Upland range site.

Verhalen Series

The Verhalen series consists of deep, calcareous clayey soils. These soils formed in loamy sediment. They are on flats and in drainageways in broad valleys. The soils are generally dry, and they have many surface cracks and potholes. The native vegetation is mainly short grasses.

In a representative profile (fig. 27) the surface layer is grayish-brown, calcareous clay about 4 inches thick. Below this is brown, very firm, calcareous clay about 22 inches thick. The next layer is brown and light-brown, calcareous clay about 22 inches thick. Below this is light reddish-brown, very firm, calcareous clay about 12 inches thick that contains a few soft masses of calcium carbonate and calcium sulfate. The underlying material is light-brown, friable, calcareous clay loam that extends to a depth of 75 inches.

Permeability is slow in these soils. Runoff is also slow.

Verhalen soils are used mainly for range. A few areas are used for irrigated crops and pasture.

Representative profile of Verhalen clay, 2 miles north of Valentine on county road, 200 feet east of road, one-half mile west of northeast corner of Sec. 200, Block 4, H&TC Ry. Co. Survey:

A11—0 to 4 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky and granular structure; slightly hard, friable, plastic and sticky; many roots; calcareous; moderately alkaline; clear, smooth boundary.

A12—4 to 26 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 3/2) moist; moderate, medium and coarse, blocky and prismatic structure; very, hard, very firm, very plastic and sticky; few roots; many slickensides below a depth of 12 inches; a few vertical cracks as much as one-half inch wide; calcareous; moderately alkaline; clear, smooth boundary.

AC1ca—26 to 30 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 4/2) moist; moderate, medium and coarse, blocky structure; very hard, very firm, very plastic and sticky; many slickensides; a few specks and soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

AC2ca—30 to 48 inches, light-brown (7.5YR 6/4) clay, dark brown (7.5YR 4/4) moist; weak, medium and coarse, blocky structure; hard, firm, very plastic and sticky; about 20 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

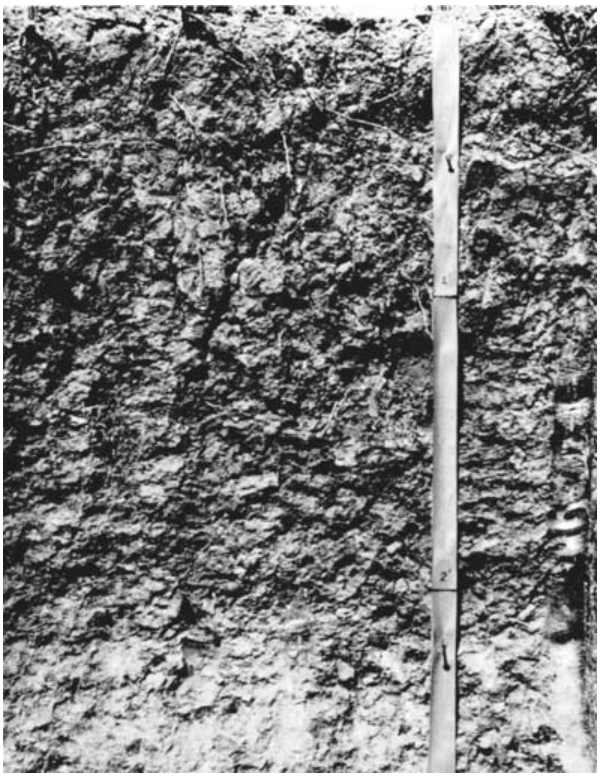

Figure 27.—Profile of Verhalen clay. Little change is noticeable in the upper 2 feet. A few specks and soft masses of lime are below a depth of 26 inches.

AC3—48 to 60 inches, light reddish-brown (5YR 6/3) clay, reddish brown (5YR 5/3) moist; weak, medium, blocky structure; very hard, very firm, very plastic and sticky; few soft masses of calcium carbonate and calcium sulfate; few black films on ped faces; calcareous; moderately alkaline; clear, smooth boundary.

C—60 to 75 inches, light-brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, plastic and sticky; calcareous; moderately alkaline.

Cracks 0.5 inch to 4 inches wide range to a depth of 20 to 30 inches where the soil is dry. Depth to the zone of carbonate accumulations ranges from 24 to 40 inches. Slickensides are distinct below a depth of 12 inches.

The A horizon ranges from 12 to 36 inches in thickness. This horizon is reddish gray, dark reddish gray, reddish brown, brown, grayish brown, or dark grayish brown. The A11 horizon is calcareous or noncalcareous, and it is mildly alkaline to moderately alkaline. The AC horizon is clay 27 to 40 inches thick. It is pinkish gray, reddish gray, dark reddish gray, light reddish brown, reddish brown, light brown, or brown. The C horizon is clay, clay loam, loam, or their gravelly analogs.

Verhalen clay (Ve).—This soil is on flats and in drainageways. It has the profile described as representative of the series. Slopes are less than 1 percent. Areas are mainly 250 to 2,500 acres in size. It was mapped in greater detail and is less variable than areas of most other mapping units in the county. The mapping has been controlled to the extent that this soil can be interpreted for irrigated farming.

Included with this soil in mapping are areas of Dalby, Musquiz, Reagan, and Redona soils. These included soils make up 0 to 20 percent of the mapping unit. The

Dalby soils are on a few narrow ridges or spots. The Reagan and Redona soils occupy small areas along the outer edges of the mapped areas.

Available water capacity is high. This soil takes in water readily when it is dry but takes it in slowly when it is wet. The hazards of soil blowing and water erosion are slight. Most areas receive extra water that runs off from adjoining soils.

This soil is generally unsuited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suited to pasture. Under good management, pasture and hay crops can be successfully established and maintained. In irrigated areas this soil has only moderate limitations that restrict its use. The clay texture impedes the movement of water and makes the soil moderately susceptible to salinity. Crop residue left on or near the surface helps maintain soil condition and permeability.

A suitable irrigation system is one that meets the needs of crops, prevents water losses, and helps control erosion. In some areas diversion terraces are needed to control outside water.

Yields of irrigated crops on this soil are estimated at 600 pounds of lint cotton, 5 tons of alfalfa hay, and 5,000 pounds of grain sorghum. Capability units VIs-1 and IIs-1 (irrigated); Clay Flat range site.

Verhalen clay, depressional (Vh).—This soil is in dry lakebeds that are inundated by water only for a short time every few years. Areas are circular to oblong; they range from 10 to 168 acres in size but average 37 acres. They were examined in greater detail and found to be less variable than most other mapped units in the county. Thus, mapping has been controlled to the extent that interpretations presented here can be applied to irrigated farming practices.

This soil is dark grayish-brown clay to a depth of 36 inches. Underlying this to a depth of 60 inches is light-brown clay. A few lime segregations and grayish mottles are below a depth of 2 feet.

Internal drainage is slow. Available water capacity is high. The soil takes in water readily when it is dry but takes it in slowly when it is wet.

This soil is unsuited to crops and pasture unless it is protected against flooding. In irrigated areas the soil has only moderate limitations that restrict its use. The clay texture impedes the movement of water, making the soil moderately susceptible to salinity. Crop residue left on or near the surface helps maintain soil condition and permeability.

A suitable irrigation system is one that meets the needs of crops and prevents water losses. Diversion terraces, dikes, or other structures are needed to control outside water.

Yields of irrigated crops on this soil are estimated to be 600 pounds of lint cotton, 5 tons of alfalfa hay, and 5,000 pounds of grain sorghum. Capability units VIs-1 and IIs-1 (irrigated); Clay Flat range site.

Verhalen-Dalby association (Vm).—This association is on flats. Slopes are less than 1 percent. Areas are mainly 250 to 2,500 acres in size.

This association is 50 to 80 percent Verhalen soils, 20 to 30 percent Dalby soils, and 0 to 20 percent other soils. Dalby soils are in the higher and drier regions of the mapped areas, and Verhalen soils are in the lower and wetter ones. Included in mapping are areas of Reagan, Hodgins, and Redona soils. As much as 10 percent of these included soils is on the outer edge of the mapped areas.

Verhalen soils have a surface layer of grayish-brown, calcareous clay about 26 inches thick. This layer is underlain by reddish-brown clay that extends to a depth of 60 inches.

Dalby soils have a surface layer of brown, calcareous clay, about 18 inches thick, that is underlain by about 18 inches of light reddish-brown, calcareous clay. The

lower layers are light-brown, calcareous silty clay. They extend to a depth of 70 inches or more and contain a few soft masses of calcium carbonates and gypsum.

The Dalby soil that has the profile described as representative for the series is in this association.

Available water capacity is high in the soils of this association. Under native vegetation, these soils have many cracks and potholes when they are dry. They take in water readily when they are dry but take it in slowly when they are wet. The hazards of water erosion and soil blowing are slight. Most areas receive extra water that runs off from adjoining higher soils.

These soils are generally unsuited to crops because of the small amount of rainfall. Areas that receive additional water by drainage or water spreading are suited to pasture. Under good management, pasture and hay crops can be established and maintained. Capability unit VIs-1; Clay Flat range site.

Vieja Series

The Vieja series consists of shallow to very shallow, well-drained, calcareous clayey soils that are underlain by shale. These soils formed under a stony mantle in residuum. They are on hillsides in the Rio Grande Basin. The native vegetation is mainly low shrubs.

In a representative profile (fig. 28) the soil is pale-brown, firm, calcareous silty clay about 8 inches thick. The underlying material is light-gray, calcareous, moderately alkaline clayey shale that extends to a depth of 40 inches or more.

Figure 28.—Profile and surface view of Vieja silty clay. The surface is covered by a large amount of stones. Shale parent material is at a depth of about 8 inches.

Permeability is moderately slow in these soils. Runoff is rapid.

Vieja soils are used only for range.

Representative profile of Vieja silty clay in an area of Vieja-Nickel association, hilly, 18 miles northwest of Valentine on U.S. Highway 90 to the junction of Farm Road 2017, 3.5 miles west on Farm Road 2017 to junction with county road, and 7 miles southwest on county road, at a cut on north side of road:

A1—0 to 8 inches, pale-brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; weak, fine, angular blocky structure; slightly hard, firm; many roots; few coarse fragments, mostly less than 1 inch in size; desert pavement of coarse fragments, mostly 1 inch to 10 inches in size, and covering 50 to 90 percent of the surface; calcareous; moderately alkaline; abrupt, smooth boundary.

C—8 to 40 inches, light-gray (2.5Y 7/2) clayey shale of silty clay texture, light brownish gray (2.5Y 6/2) moist; hard, crumbles easily when moist; distinct bedding planes; calcareous; moderately alkaline.

The solum ranges from 4 to 20 inches deep to shale.

The A horizon is pale-brown, light brownish-gray, pale-yellow, or light brownish-yellow clay loam, gravelly clay loam, silty clay loam, or silty clay that is 35 to 50 percent clay. The C horizon is light yellowish-brown, light brownish-gray, grayish-brown, light olive-brown, light-gray, or pale-yellow clayey shale that is brittle where dry and of high density.

Vieja-Nickel association, hilly (VnE).—This association is on hills on gravelly and clayey material. Slopes are mostly 10 to 30 percent, but on some hilltops they are about 3 to 10 percent. Areas are irregularly shaped, long, and broad and range from 250 to 9,600 acres in size.

This association is 50 to 70 percent Vieja soils, 30 to 40 percent Nickel soils, and 10 to 20 percent other soils and land types. Vieja soils are on the hillsides and foot slopes of hills. Nickel soils are on the gravelly top of hills. Included in mapping are areas of Glendale soils in the narrow drainageways that drain these hills. Small areas of eroded scarps of hills and Rock outcrop along basaltic dikes are also included.

The Vieja soil that has the profile described as representative of the series is in this association.

Nickel soils have a surface layer of light-brown gravelly loam about 6 inches thick. The next layer is white, gravelly, fragmented caliche about 15 inches thick. Below this and extending to a depth of 40 inches or more is very pale brown very gravelly loam.

Available water capacity is low in the soils of this association. The Vieja soils have a slight hazard of soil blowing and a severe hazard of water erosion. The Nickel soils have slight hazards of soil blowing and water erosion.

These soils are used only for native range and as wildlife habitat. Vieja soils in capability unit VIIs-4; Desert Hill range site. Nickel soils in capability unit VIIs-1; Gravelly range site.

Volco Series

The Volco series consists of shallow to very shallow, well-drained, calcareous gravelly soils that are underlain by igneous bedrock. These soils formed in loamy material that accumulated in stony rubble. They are on hillsides. Elevation is mainly 4,000 to 4,500 feet. The native vegetation is short grasses and, in places, a few low shrubs.

In a representative profile the surface layer is grayish-brown, calcareous gravelly loam about 4 inches thick that is 40 percent, by volume, igneous and caliche rock fragments. The next layer is brown, friable, calcareous gravelly loam about 5 inches

thick that is 55 percent, by volume, lime-coated igneous rock fragments. Below this is grayish, platy igneous bedrock.

Permeability is moderate in these soils. Runoff is rapid.

Volco soils are used only for range.

Representative profile of Volco loam in an area of Volco association, hilly, about 4.7 miles north of Valentine, one-fourth mile north of the southeast corner of Sec. 52, Block 4, GH&SA Ry. Co. Survey:

A1—0 to 4 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, platy and subangular blocky structure; slightly hard, friable; many roots; 40 percent, by volume, igneous and caliche rock fragments that consist of 25 percent gravel, 10 percent cobbles, and 5 percent stones; calcareous; moderately alkaline; clear, smooth boundary.

A1ca—4 to 9 inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; many roots; 55 percent, by volume, lime-coated igneous and caliche rock fragments that consist of 35 percent gravel, 10 percent cobbles, and 10 percent stones; calcareous; moderately alkaline; abrupt, irregular boundary.

R&Cca—9 to 18 inches, grayish, fractured, platy igneous bedrock; weakly cemented in upper part and strongly cemented below; lime coatings on surface and in fractures; hard, pale-brown (10YR 6/3) loamy material in fractures; few roots; diffuse boundary.

R—18 to 20 inches, grayish, platy igneous bedrock; indurated.

The solum ranges from 6 to 18 inches in thickness. Depth to the R horizon is 8 to 20 inches. The soil ranges from 35 to 80 percent, by volume, coarse fragments that are 30 to 70 percent gravel, 2 to 20 percent cobbles, and 0 to 15 percent stones. Reaction is mildly alkaline or moderately alkaline.

The A horizon is grayish-brown, dark grayish-brown, brown, or reddish-gray sandy loam, loam, or clay loam. The lower part of the A horizon has an accumulation of calcium carbonate as coatings on fragments, as soft masses, and as threads and films. The calcium carbonate equivalent is 20 to 35 percent. The R horizon is igneous bedrock that has caliche coatings on the surface and in fractures in the upper part. The lower part is mainly rhyolitic or basaltic volcanics.

Volco association, hilly (VoE).—This association is on igneous hills. Slopes are mostly 10 to 30 percent, but they range to 5 percent. Areas are mainly 100 to 1,000 acres in size.

This association is 60 to 80 percent Volco gravelly loam, 10 to 30 percent Brewster stony loam, and 10 to 20 percent other soils or Rock outcrop. Volco soils are on the top and sides of hills. Brewster soils are on the steeper side slopes near the top of hills. Included in mapping are small areas of Vado, Nickel, Hodgins, Reagan, and Ima soils on foot slopes at the base of the hills. Rock outcrop is also included at scarps on some of the hills.

The Volco soil that has the profile described as representative of the series is in this association.

Available water capacity is low in the Volco soils of this association. Runoff is rapid. Because of stones and shallowness, plants make effective use of light rainfall, but most of the water from heavy rainfall runs off. Unless the soils are protected by a cover of grass, the hazard of water erosion is severe. The hazard of soil blowing is slight.

These soils are too stony and too shallow for pasture and crops. They are suited to range. Capability unit VIIs-4; Igneous Hill and Mountain range site.

Use and Management of the Soils

In this section the capability classification system is explained. The soils of the county are placed in capability units, and a listing of these units within the system is given. This section also covers use of the soils for range, woodland, wildlife habitat, engineering, and recreation.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. The subclass indicates major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* indicates that the chief limitation is climate that is too cold or too dry.

Class I contains no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses w, s, and c, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, wildlife habitat, or recreation.

Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally; for example, I-1 (irrigated) and IVc-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

All the capability units of Jeff Davis County are dryland units except I-1 and IIs-1, which are irrigated units. Only a small acreage of the soils of the county is used for crops, and almost all of this acreage is irrigated. Larger acreages can be irrigated if desired and if water is available. Soils suited for irrigated crops are Anthony, Chispa, Dalby, Gageby, Glendale, Hodgins, Ima, Medley, Musquiz, Phantom, Reagan,

Redona, Rockhouse, Sanderson, Santo Tomas, Vado, and Verhalen soils. Yields on Hodgins clay loam, 0 to 1 percent slopes (HoA), in irrigated capability unit I-1, are estimated at 1,500 pounds of lint cotton, 5,000 pounds of grain sorghum, and 6 tons of alfalfa hay. Yields on Verhalen clay (Ve) and Verhalen clay, depressional (Vh), both in irrigated capability unit IIs-1, are estimated at 600 pounds of lint cotton, 5,000 pounds of grain sorghum, and 5 tons of alfalfa hay.

The main concerns of management for irrigated crops are maintaining soil condition and managing water. Crop residue should be kept on or near the soil surface to control soil blowing and maintain soil tilth. A designed irrigation system is needed to help match water application to crop needs, prevent the loss of water, and control erosion. For some soils, terraces or dikes are needed to control outside water. A few others need protection from flooding.

In the following list the capability units in the system for Jeff Davis County are briefly described. To learn the unit in which any soil in the county has been placed, refer to that soil mapping unit in the section "Descriptions of the Soils" or to the "Guide to Mapping Units, (Removed)" at the back of this survey.

Class I. Soils have few limitations that restrict their use (no subclasses).
- Unit I-1 (irrigated). Deep, nearly level, calcareous loamy soils that have high available water capacity.

Class II. Soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIs. Soils moderately limited by slow permeability.
  - Unit IIs-1 (irrigated). Deep, nearly level to gently sloping, calcareous clayey soils that have high available water capacity.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both (none in Jeff Davis County).

Class IV. Soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe-1. Deep, gently sloping, noncalcareous loamy soils that have high available water capacity.
  - Unit IVe-2. Deep, gently sloping to undulating, calcareous to noncalcareous loamy soils that have high available water capacity.
- Subclass IVc. Soils very severely limited by climate.
  - Unit IVc-1. Deep, nearly level, calcareous to noncalcareous loamy soils that have high available water capacity.

Class V. Soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.
- Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw-1. Deep, nearly level, noncalcareous loamy soils that have high available water capacity.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Subclass VIe. Soils severely limited, chiefly by risk of erosion unless protective cover is maintained.
  - Unit VIe-1. Deep, gently sloping, calcareous loamy soils that have medium available water capacity.
  - Unit VIe-2. Deep, rolling, noncalcareous loamy soils that have high available water capacity.

Subclass VIs. Soils severely limited by slow permeability, shallow depth, or gravel or cobbles in the soil.
Unit VIs-1. Deep, nearly level, calcareous clayey soils that have high available water capacity.
Unit VIs-2. Deep, nearly level, noncalcareous loamy soils that have low available water capacity.
Unit VIs-3. Deep, undulating, calcareous gravelly loam soils that have low to medium available water capacity.
Unit VIs-4. Deep, gently sloping and rolling, noncalcareous gravelly loam to very gravelly loam soils that have low to medium available water capacity.
Unit VIs-5. Moderately steep, gently sloping, noncalcareous loamy soils that have medium available water capacity.
Unit VIs-6. Shallow to very shallow, gently sloping, calcareous loam and gravelly loam soils that have low available water capacity.
Unit VIs-7. Shallow, gently sloping, noncalcareous cobbly loam to gravelly loam soils that have low available water capacity.
Unit VIs-8. Deep, undulating, calcareous loamy soils that have low available water capacity.
Subclass VIc. Soils severely limited by climate.
Unit VIc-1. Deep, nearly level to gently sloping, calcareous loamy soils that have high available water capacity.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife habitat.
Subclass VIIe. Soils very severely limited, chiefly by risk of erosion unless protective cover is maintained.
Unit VIIe-1. Nearly level to gently sloping, severely eroded soils.
Subclass VIIs. Soils very severely limited by soil depth, slope, or rocks, gravel, or cobbles in the soil.
Unit VIIs-1. Deep to very shallow, undulating to hilly, calcareous gravelly loam soils that have low available water capacity.
Unit VIIs-2. Shallow to very shallow, undulating, calcareous gravelly loam soils that have low available water capacity.
Unit VIIs-3. Moderately deep to very shallow, hilly to steep, noncalcareous gravelly to cobbly loam soils and land types that have low to medium available water capacity.
Unit VIIs-4. Shallow to very shallow, undulating to hilly, calcareous gravelly loam and clayey soils and land types that have low available water capacity.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.
Subclass VIIIs. Landforms that are eroded and steep.
Unit VIIIs-1. Sloping to steep, eroded lava ash formations.

Use of the Soils for Range

Dean Chamrad, range conservationist, Soil Conservation Service, prepared this section.

Approximately 99 percent, or 1,431,760 acres, of the land area of Jeff Davis County is range, used mainly for grazing domestic livestock and wildlife. Range provides numerous benefits in addition to their primary use for grazing. Other benefits provided by the range include wildlife habitat, recreation, watershed, ground water recharge, historic and cultural sites, natural areas, and esthetic beauty. The range of

Jeff Davis County thus benefits many people beyond the private landowner who controls and manages these resources.

RANGE SITES.—The inherent productive capacity of different areas of range depends mainly upon the combined effects of the environmental factors peculiar to them. The concept of the range site expresses these differences in productive capacity.

A range site is an area that has the potential to produce given kinds and amounts of vegetation, resulting in a characteristic plant community that differs significantly from other plant communities in kind or amount of plants. The potential, or climax, plant community is the product of heredity and all environmental factors responsible for its development. The climax plant community is in dynamic equilibrium with its environment and does not change drastically, unless it is subjected to conditions that alter or change direct site factors of soil water, soil air, soil nutrients, soil temperature, air temperature, humidity, and light.

Such cultural practices as continuous heavy grazing or soil disturbances can cause deterioration or destruction of the climax plant community. Under such conditions the climax community dominants may be replaced by species of lower successional status or by invading species from outside the community. The climax plant community is capable of reproducing itself through the process of secondary plant succession, provided that site factors are not permanently altered.

RANGE CONDITIONS.—This is the present status of vegetation of a range site in relation to the potential plant community for that site. Range condition classes are used to express the degree to which the present plant species composition, expressed in percent by weight of annual yield, has departed from that of the climax plant community of a given range site. Four range condition classes are recognized. Condition is *excellent* if 76 to 100 percent of the present vegetation consists of that found in the climax plant community, *good* if 51 to 75 percent, *fair* if 26 to 50 percent, and *poor* if 25 percent or less. Knowledge of range sites and range conditions provides a basis for predicting the nature and direction of plant community changes to be expected from management and treatment measures on range.

The range site concept, in conjunction with range condition classification, provides a sound ecological basis for inventory and appraisal of range resources. The range site aids the land user in identifying areas of range that have different potential for vegetation production, regardless of what they may be presently producing. Range condition provides an approximate measure of changes that have taken place in the range plant community.

VEGETATIVE ZONES.—A general vegetative description is given for the major vegetative zones in Jeff Davis County. Range vegetation varies greatly throughout the county, and general vegetation types coincide closely with major climatic zones. Native vegetation throughout the county makes most of its annual production during summer, when most of the annual rainfall occurs. Grazing management must be flexible and closely keyed to plant growth cycles and fluctuations in seasonal and annual forage production. Range sites are described under the climatic zone or zones where they occur.

Range sites are described relative to kinds of soils and soil properties that influence plant growth. The approximate climax plant community for each site is given. The approximate total annual yield is given as air-dry weight in pounds per acre for range in excellent condition, representative of years of both favorable and unfavorable growing conditions.

Desert Shrub vegetative zone

The Desert Shrub vegetation zone is in the western part of the county, near the Rio Grande. The climate and soils support a sparse cover of vegetation that is characteristic of the Chihuahuan Desert.

This climax vegetation is mainly drought-tolerant shrubs, cacti, and perennial grasses, generally in a widely spaced pattern with an abundance of barren soil or desert pavement among them. The dominant perennial plants include creosotebush, acacias, ocotillo, yuccas, lechuguilla, cacti, chino grama, black grama, bush muhly, three-awns, and burrograss.

DESERT HILL RANGE SITE

This site consists of very shallow to shallow, well-drained, hilly, calcareous clayey soils. Permeability is moderately slow in these soils. Runoff is rapid. Available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The climax vegetation is drought-tolerant bunch-grasses, stoloniferous grasses, and desert shrubs. The composition by weight of the climax vegetation, or potential plant community, is about 15 percent chino grama; 12 percent alkali sacaton; 12 percent tobosa; 10 percent black grama; 10 percent side-oats grama and cane bluestem; 4 percent fall witchgrass, three-awns, Arizona cottontop, and plains bristlegrass; 2 percent burrograss and fluffgrass; 3 percent perennial forbs; 2 percent annual grasses and forbs; 10 percent skeletonleaf goldeneye; 10 percent range and white ratany; and 10 percent other woody species, lechuguilla, ocotillo, and cacti.

Continuous heavy grazing by cattle on this site results in a decrease in chino grama, black grama, side-oats grama, cane bluestem, and fall witchgrass. Alkali sacaton, tobosa, burrograss, and range ratany initially increase, but eventually decrease under prolonged overgrazing. Where there is prolonged overgrazing and site deterioration, fluff grass, annual three-awns, forbs, and such woody species as acacias, creosotebush, and mesquite increase and invade the site.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 600 pounds per acre in favorable years and 300 pounds in unfavorable years.

DRAW RANGE SITE

This site consists of deep, well-drained, nearly level, calcareous loamy soils. Permeability is moderately slow to moderately rapid in these soils. Runoff is slow to medium. Available water capacity is high. The hazards of soil blowing and water erosion are slight. These soils are occasionally flooded in summer.

The vegetation on this post-climax site is dominantly mid and short grasses of bunch and stoloniferous growth forms. Some woody plants and annuals also are common. The composition by weight of the climax vegetation, or potential plant community, is about 15 percent side-oats grama; 10 percent vine-mesquite; 10 percent alkali sacaton; 10 percent cane bluestem and twoflowered trichloris; 8 percent pink and whiplash pappusgrass; 8 percent tobosa and white tridens; 11 percent other perennial grasses; 6 percent perennial forbs; 2 percent annual forbs; 5 percent fourwing salt-bush; 10 percent guayacan, tarbush, and apache-plume; and 5 percent other woody species.

Continuous heavy grazing on this site results in a decrease in side-oats grama, vine-mesquite, alkali sacaton, cane bluestem, and pink pappusgrass. Under prolonged continuous heavy grazing, tobosa, whiplash pappusgrass, white tridens, perennial three-awn, and burrograss increase initially and then decrease. Where there is prolonged overgrazing and site deterioration, such woody species as acacias, tarbush, whitebrush, spiny hackberry, and mesquite increase, and creosotebush invades the site.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,000 pounds per acre in favorable years and 600 pounds in unfavorable years.

GRAVELLY RANGE SITE

This site consists of very shallow to deep, well-drained, undulating to hilly, calcareous gravelly loamy soils. Permeability is moderate to moderately rapid in these soils. Runoff is medium. Available water capacity is low to high. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

The climax vegetation is drought-tolerant bunchgrasses and stoloniferous grasses in association with an abundance of woody shrubs. The composition by weight of the climax vegetation, or potential plant community, is about 15 percent side-oats grama; 24 percent black grama and chino grama; 10 percent bush muhly; 10 percent perennial three-awns and slim and rough tridens; 6 percent other perennial grasses; 3 percent perennial forbs; 2 percent annual forbs and grasses; 8 percent acacias and catclaw; 4 percent creosotebush; 8 percent range ratany and feather dalea; 3 percent skeletonleaf goldeneye; and 7 percent ephedra, cacti, lechuguilla, and ocotillo.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, black grama, chino grama, and bush muhly and an increase in burrograss, false grama, fluffgrass, and annuals. Under prolonged continuous heavy grazing, creosotebush increases and becomes dominant in the plant community. Overgrazing by sheep, goats, and deer tends to decrease menodora, bladderpod, and such shrubs as feather dalea, skeletonleaf goldeneye, and kidneywood.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 700 pounds per acre in favorable years and 300 pounds in unfavorable years.

GRAVELLY OUTWASH RANGE SITE

This site consists of deep, excessively drained, rolling, calcareous gravelly loamy soils. Permeability is rapid in these soils. Runoff is rapid. Available water capacity is low. The hazards of soil blowing and water erosion are slight.

The climax vegetation is grasses, shrubs, and annuals. The composition by weight of the climax vegetation, or potential plant community, is about 12 percent chino grama; 10 percent black grama; 8 percent side-oats grama; 5 percent bush muhly; 15 percent other perennial grasses, such as three-awns, slim and rough tridens, dropseeds, red grama, and fluffgrass; 5 percent perennial forbs; 10 percent annual grasses and forbs; 15 percent acacias; 10 percent range and white ratany, feather dalea, guayacan, and creosotebush; and 10 percent yucca, ephedra, ocotillo, cholla, lechuguilla, and cacti.

Continuous heavy grazing by cattle on this site results in a decrease in such plants as side-oats grama, black grama, bush muhly, chino grama, sand dropseed, and slim tridens, and an increase in such plants as red grama, fluffgrass, and annual grasses and forbs. Under prolonged continuous heavy grazing, the grass cover and woody species, especially acacias, catclaw, and creosotebush, increase to dominate the site.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 450 pounds per acre in favorable years and 250 pounds in unfavorable years.

LIMESTONE HILL AND MOUNTAIN RANGE SITE

This site consists of very shallow to shallow, well-drained, hilly, calcareous gravelly loamy soils and land types. Permeability is moderate in these soils. Runoff is medium to rapid. Available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The climax vegetation is dominantly short and mid grasses in association with many shrubs and forbs (fig. 29). The composition by weight of the climax vegetation, or potential plant community, is about 18 percent chino grama; 8 percent slim and rough tridens; 8 percent perennial three-awn; 8 percent bush muhly and black grama;

Figure 29.—Area of Lozier-Rock outcrop association, hilly, in Limestone Hill and Mountain range site, Desert Shrub vegetation zone.

8 percent side-oats grama and tanglehead; 12 percent green sprangletop, plains bristlegrass, and Arizona cottontop; 8 percent other perennial grasses; 10 percent perennial forbs; 15 percent skeletonleaf goldeneye, feather dalea, ceniza, and bernardia; and 5 percent other woody species, sotol, lechuguilla, and candellia.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, green sprangletop, black grama, plains bristlegrass, bush muhly, tanglehead, slim tridens, perennial three-awn, and such palatable forbs as bladderpod, menodora, guara, milkwort, and globemallow. These forbs and a number of others also decrease under heavy grazing by sheep and deer. Prolonged continuous heavy grazing tends to reduce the vigor and production of such shrubs as skeletonleaf goldeneye, feather dalea, kidneywood, vine ephedra, southwest bernardia, and range ratany. Prolonged overgrazing results in an increase of such species as accacias; ocotillo, creosotebush, agarito, javelinebush, pricklypear, tasajillo, and other woody plants and cacti.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 300 pounds per acre in favorable years and 100 pounds in unfavorable years.

Desert Grassland vegetative zone

The Desert Grassland vegetative zone is mostly at elevations of 3,500 to 4,500 feet. The climate and soils support a sparse cover of grasses and shrubs.

The climax vegetation is mainly such short grasses as blue grama, black grama, burrograss, tobosa, and, in places such mid grasses as cane bluestem, side-oats grama, Arizona cottontop, and plains bristlegrass. Primary shrubs include butterflybush, fourwing saltbush, and tarbush. Much of this zone has been invaded by such woody species as creosotebush, tarbush, acacias, and mesquite.

CLAY FLAT RANGE SITE

This site consists of deep, well drained to moderately well drained, nearly level to gently sloping and depressional, calcareous loamy to clayey soils. Permeability is moderately slow to very slow in these soils. Runoff is very slow to moderate. Available water capacity is high. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

The climax vegetation is dominantly grasses and annual weeds. Perennial forbs and woody species are scarce in the climax community. The composition by weight of the climax vegetation, or potential plant community, is about 50 percent tobosa; 10 percent vine-mesquite; 10 percent blue grama; 6 percent side-oats grama; 5 percent cane bluestem; 5 percent sand muhly, mat muhly, alkali sacaton, plains bristlegrass, and Arizona cottontop; 12 percent annual grasses and forbs; and 2 percent fourwing saltbush and butterflybush.

Continuous heavy grazing on this site results in a decrease in side-oats grama, blue grama, Arizona cottontop, plains bristlegrass, vine-mesquite, and cane bluestem, and an initial increase in tobosa. Under prolonged continuous heavy grazing, sand muhly, burrograss, and perennial three-awn continue to increase after stands of tobosa begin to deteriorate. Annual grasses and forbs are a natural part of the climax community, but as the site deteriorates the annual grasses increase strongly. Where there is prolonged overgrazing and site deterioration, mesquite, broom snakeweed, lotebush, and javelinebush often invade the deteriorated site. Stands of tobosa are easily destroyed by mechanical disturbances. Replacement vegetation is difficult to establish, however, and the process is frequently hazardous.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,750 pounds per acre in favorable years and 400 pounds in unfavorable years.

DEEP UPLAND RANGE SITE

This site consists of deep, well-drained, nearly level to gently sloping, calcareous to noncalcareous loamy soils. Permeability is moderate in these soils. Runoff is slow to medium. Available water capacity is high. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

The climax vegetation is dominantly short and mid grasses. The vegetation is broken or spotty. Small, slightly depressed "microsites" are in this site. The composition by weight of the climax vegetation, or potential plant community, is about 30 percent blue grama; 15 percent black grama; 10 percent burrograss; 5 percent tobosa; 8 percent plains bristlegrass and Arizona cottontop; 6 percent side-oats grama and cane bluestem; 6 percent perennial three-awns and bush muhly ; 10 percent other perennial grasses and annuals; 5 percent perennial forbs, such as menodora, Mexican sagewort, croton, and bladderpod; and 5 percent woody plants and others, such as butterflybush, four-wing saltbush, tarbush, range ratany, ephedra, cholla, and yucca.

Continuous heavy grazing by cattle on this site results in a decrease in blue grama, cane bluestem, side-oats grama, black grama, plains bristlegrass, Arizona cottontop, and such forbs and shrubs as menodora, sagewort, and butterflybush. Other species, including sand muhly, burrograss, tobosa, perennial three-awns, ear muhly, sand dropseed, and annual weeds, increase under continuous heavy grazing. Where there is prolonged overgrazing and site deterioration, tarbush and javelinebush increase and creosotebush invades the deteriorated site. Such herbaceous species as fluffgrass, sixweeks grama, annual three-awns, bahia, crotons, dogweed, silverleaf nightshade, and broom snakeweed also invade the site where deterioration is severe.

Where this site receives sufficient outside water, it can sometimes be artificially revegetated by range seeding in conjunction with mechanical brush control and proper seedbed modifications.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,000 pounds per acre in favorable years and 600 pounds in unfavorable years.

DRAW RANGE SITE

This site consists of deep, well-drained, nearly level, noncalcareous loamy soils. Permeability is rapid in these soils. Runoff is slow to medium. Available water capacity is low. The hazards of soil blowing and water erosion are slight. These soils are occasionally flooded in summer.

The climax vegetation is bunchgrasses and stoloniferous grasses of the mid and short grass forms, perennial forbs, and woody shrubs. The composition by weight of the climax vegetation, or potential plant community, is about 28 percent cane bluestem; 12 percent side-oats grama; 12 percent blue grama; 10 percent vine-mesquite; 15 percent green sprangletop, Arizona cottontop, and plains bristlegrass; 9 percent tobosa and bush muhly; 2 percent other perennial and annual grasses; 5 percent such perennial forbs as menodora, Mexican sagewort, hairy tubetongue, and annual forbs; and 7 percent such woody plants as butterflybush, fourwing saltbush, oldman's beard, and wolfberry.

Continuous heavy grazing by cattle on this site results in a decrease in cane bluestem, side-oats grama, green sprangletop, plains bristlegrass, Arizona cottontop, blue grama, vine-mesquite, bush muhly, menodora, sagewort, and butterflybush and an increase in tobosa, sand dropseed, alkali sacaton, and burrograss. White-brush, catclaw, wolfberry, and tarbush also increase and dominate as the plant community continues to deteriorate. Where there is prolonged overgrazing and site deterioration, mesquite, javelinebush, lotebush, and agarito invade the deteriorated site.

This site is well adapted to mechanical brush control practices. It receives sufficient overflow and runoff for artificial revegetation by range seeding.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,000 pounds per acre in favorable years and 1,500 pounds in unfavorable years.

FOOTHILL SLOPE RANGE SITE

This site consists of deep to shallow, well-drained, gently sloping, noncalcareous gravelly loamy soils. Permeability is slow to moderate in these soils. Runoff is medium. Available water capacity is low to medium. The hazards of soil blowing and water erosion are slight.

The climax vegetation is short and mid grasses and a mixture of forbs and woody plants. The composition by weight of the climax vegetation, or potential plant community, is 15 percent black grama; 10 percent side-oats grama; 10 percent bush muhly; 10 percent tobosa; 5 percent cane bluestem; 5 percent plains bristlegrass; 5 percent blue grama and hairy grama; 5 percent perennial three-awns; 5 percent slim and rough tridens; 10 percent sand dropseed, green sprangletop, Arizona cottontop, and tanglehead; 5 percent perennial forbs, including menodora, bushsunflower, daleas, broom snakeweed, bladderpod, globemallow, and croton; and 15 percent such woody plants as range ratany, acacias, feather dalea, mariola, skeletonleaf goldeneye, and butterflybush and tasajillo.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, cane bluestem, tanglehead, plains bristlegrass, blue grama, bush muhly, such perennial forbs as bushsunflower and menodora, butterflybush, and skeletonleaf goldeneye and an increase in black grama, sand dropseed, tobosa, slim tridens, perennial three-awns, and hairy grama. Prolonged overgrazing results in a

plant community dominated by acacias, mariola, cholla, pricklypear, and creosotebush.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,200 pounds per acre in favorable years and 800 pounds in unfavorable years.

GRAVELLY RANGE SITE

This site consists of very shallow to deep, well-drained, undulating, calcareous loamy and gravelly loamy soils. Permeability is moderate to moderately rapid in these soils. Runoff is medium. Available water capacity is low to high. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

The climax vegetation is sparse stands of dominantly short and mid grasses. Small, slightly depressed "microsites" support more mid grasses than other areas of this site. The composition by weight of the climax vegetation, or potential plant community, is 15 percent bush muhly; 15 percent black grama; 10 percent slim tridens; 5 percent perennial three-awns; 5 percent blue grama; 7 percent side-oats grama, Arizona cottontop, and plains bristlegrass; 5 percent mesa, sand, and spike dropseeds; 5 percent burrograss, tobosa, fluff grass, and red grama; 10 percent such perennial forbs as bladderpod, menodora, globemallow, bahia, and broom snakeweed; 3 percent annual forbs and grasses; 5 percent creosotebush; 5 percent range ratany; 3 percent javelinebrush, lotebush, and allthorn; 3 percent tarbush and mariola; 2 percent acacias; and 2 percent ephedra, yucca, and cacti.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, black grama, blue grama, bush muhly, and such palatable forbs as menodora, globemallow, and hairy tubetongue and an increase in range ratany, mariola, perennial three-awns, slim tridens, sand dropseed, burrograss, fluffgrass, broom snakeweed, and annuals. Where there is prolonged overgrazing and site deterioration, creosotebush increases and often becomes the dominant species along with increasingly large amounts of bare soil.

This site generally is unsuitable for artificial revegetation.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 750 pounds per acre in favorable years and 300 pounds in unfavorable years.

IGNEOUS HILL AND MOUNTAIN RANGE SITE

This site consists of very shallow to shallow, well-drained, hilly to steep, calcareous to noncalcareous gravelly loamy soils and land types. Permeability is moderate in these soils. Runoff is rapid. Available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The climax vegetation is dominantly short and mid grasses and some perennial forbs and woody shrubs. The composition by weight of the climax vegetation, or potential plant community, is 20 percent black grama; 15 percent side-oats grama; 10 percent cane bluestem and tanglehead; 8 percent green sprangletop; 5 percent blue grama and hairy grama; 5 percent tobosa; 10 percent bush muhly, Arizona cottontop, plains bristlegrass, and plains lovegrass; 7 percent spider three-awn, slim tridens, fall witchgrass, and fluffgrass; 8 percent perennial forbs, including sticky selba, mentzellia, bushsunflower, menodora, wildbuckwheat, verbena, hairy tubetongue and dahlias; 4 percent skeletonleaf goldeneye; 3 percent narrowleaf foresteria, range ratany, shrubby sage, and feather and black dalea; 3 percent bush croton, mariola, and skunkbush; and 2 percent pricklypear, lechuguilla, yucca, sotol, and sacahuista.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, black grama, blue grama, cane bluestem, tanglehead, and green sprangletop and an initial increase in tobosa, hairy grama, fall witchgrass, and slim tridens. Overgrazing by sheep or goats results in a decrease in all major perennial forbs, skeletonleaf goldeneye, bush croton, skunkbush, and shrubby sage. Prolonged

overgrazing results in an increase in such annuals as pricklypear, lechuguilla, and sacahuista.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,200 pounds per acre in favorable years and 750 pounds in unfavorable years.

LIMESTONE HILL AND MOUNTAIN RANGE SITE

This site consists of very shallow to shallow, well-drained, undulating to hilly, calcareous gravelly loamy soils. Permeability is moderate in these soils. Runoff is rapid to medium. The hazard of soil blowing is slight, and the hazard of water erosion is severe. Available water capacity is low.

The climax vegetation is dominantly mid and short grasses and an abundance of perennial forbs and woody shrubs. The composition by weight of the climax vegetation, or potential plant community, is 15 percent side-oats grama; 10 percent cane bluestem; 5percent little bluestem; 5 percent black grama; 5 percent green sprangletop; 5 percent fall witchgrass; 5 percent perennial three-awn; 12 percent tanglehead, plains lovegrass, Arizona cottontop, and plains bristlegrass; 8 percent chino grama, blue grama, hairy grama, and bush muhly; 5 percent slim tridens, hairy tridens, and Halls panicum; 10 percent perennial forbs, including menodora, dalea, blackfoot daisy, sundrops, grassland croton, bladderpod, greenthread, milkwort, and hairy tubetongue; 5 percent woody shrubs, including skeletonleaf goldeneye; 5 percent feather and black dalea, range ratany, bernardia, kidneywood, and mountainmahogany; and 5 percent acacias, other woody species, yucca, cacti, and lechuguilla.

Continuous heavy grazing by cattle on this site results in a decrease in the bluestems, side-oats grama, blue grama, black grama, green sprangletop, plains bristlegrass, and plains lovegrass and an initial increase in hairy grama, Halls panicum, three-awns, fall witchgrass, slim tridens, acacias, mariola, and other woody species. Continuous heavy grazing by sheep or deer tends to decrease such forbs as menodora, sundrop, blackfoot, daleas, and perennial bladderpod. Side-oats grama, green sprangletop, plains bristlegrass, plains lovegrass, and fall witchgrass also decrease under continuous heavy grazing by sheep. Excessive browsing by goats, deer, or other animals reduces the vigor and production of bernardia, skeletonleaf goldeneye, feather dalea, kidneywood, and skunkbush.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 800 pounds per acre in favorable years and 200 pounds in unfavorable years.

SANDY LOAM RANGE SITE

This site consists of deep, well-drained, gently sloping, calcareous loamy soils. Permeability is moderately rapid to moderate in these soils. Runoff is medium to slow. Available water capacity is medium to high. The hazard of soil blowing is high, and the hazard of water erosion is moderate.

The climax vegetation is dominantly mid and short grasses, forbs, and a few woody shrubs. The composition by weight of the climax vegetation, or potential plant community, is 25 percent black grama; 30 percent mesa, sand, and spike dropseeds; 5 percent blue grama; 5 percent perennial three-awn; 5 percent plains bristlegrass; 5 percent Arizona cottontop; 5 percent fall witchgrass and bush muhly; 10 percent perennial forbs, such as globemallow, guara, sundrops, wildbuckwheat, and mentzellia; 5 percent annual forbs and grasses; and 5 percent shrubs, such as fourwing saltbush, ephedra, catclaw, wolfberry, range ratany, sand sage, and yucca.

Continuous heavy grazing by cattle on this site results in a decrease in black grama, plains bristlegrass, bush muhly, and Arizona cottontop and an initial increase in the dropseeds, fall witchgrass, three-awns, signalgrass, and sandbur. Prolonged overgrazing results in a plant community dominated by signalgrass, sandbur,

annuals, and such woody species as lotebush, wolfberry, acacias, javelinebush, and mesquite.

If this site is in excellent condition, the total annual yield of air-dry herbage is 1,200 pounds per acre in favorable years and 600 pounds in unfavorable years.

Mountain Grassland vegetative zone

The Mountain Grassland vegetative zone is mostly at elevations of 4,500 to 5,500 feet. This zone includes intermountain prairies and valleys and rolling to steep hills and mountainsides. The climate and soils support a climax vegetation of short and mid grasses and only a few low shrubs and trees.

The climax vegetation is mainly side-oats grama, cane bluestem, blue grama, and black grama. Such woody vegetation as butterflybush, oaks, daleas, and acacias is in draws or on rocky slopes of hills and mountains.

DEEP UPLAND RANGE SITE

This site consists of deep, well-drained, nearly level to gently sloping, noncalcareous loamy soils. Permeability is moderately slow in these soils. Runoff is slow to medium. Available water capacity is high. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

The climax vegetation is dominantly a mixture of short and mid grasses. The composition by weight of the climax vegetation, or potential plant community, is 35 percent blue grama; 20 percent side-oats grama; 10 percent cane bluestem; 5 percent black grama; 5 percent Arizona cottontop; 5 percent plains bristlegrass; 2 percent vine-mesquite; 2 percent bottlebrush squirreltail; 10 percent other perennial grasses, including hairy grama, tobosa, spider three-awn, sand muhly, buffalograss, burrograss, plains lovegrass, and annual grasses; 5 percent annual forbs and perennial forbs, including croton, bladderpod, Mexican sagewort, and bundleflower; and 1 percent woody plants and such others as butterflybush, winterfat, ephedra, cholla, and yucca.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, cane bluestem, green sprangletop, Arizona cottontop, plains bristlegrass, and vine-mesquite and an increase in blue grama, black grama, hairy grama, tobosa, burrograss, and others. Prolonged overgrazing and site deterioration eventually result in a decrease in all these species and an increase in or invasion of perennial and annual woody species of grasses and forbs, such as javelinebush, mesquite, catclaw, and allthorn.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,000 pounds per acre in favorable years and 1,000 pounds in unfavorable years.

DRAW RANGE SITE

This site consists of deep, well-drained, nearly level, noncalcareous loamy soils. Permeability is moderate to rapid in these soils. Runoff is slow to medium. Available water capacity is high to low. The hazards of soil blowing and water erosion are slight. These soils are occasionally flooded in summer.

The climax vegetation is grasses and an intermittent overstory of shrubs and trees. The composition by weight of the climax vegetation, or potential plant community, is 20 percent side-oats grama; 20 percent cane bluestem; 12 percent vine-mesquite; 5 percent green sprangletop; 5 percent blue grama; 4 percent Arizona cottontop; 2 percent bulbo panicum; 8 percent other perennial grasses, including plains lovegrass, plains bristlegrass, alkali sacaton, giant sacaton, pinyon rice-grass, thinstem stipa, tobosa, spider three-awn, and annual grasses; 4 percent perennial and annual forbs; and 20 percent woody species, including walnut, western

soapberry, willow, cottonwood, oak, baccharis, apacheplume, brickellbush, and whitebrush.

Continuous heavy grazing by cattle on this site results in a decrease in side-oats grama, cane bluestem, green sprangletop, vine-mesquite, Arizona cottontop, and bulbosum panicum and an initial increase in blue grama, alkali sacaton, and tobosa. Prolonged overgrazing results in an invasion of whitebrush, catclaw, mesquite, baccharis, other woody species, and woody annual and perennial grasses and forbs.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,500 pounds per acre in favorable years and 1,500 pounds in unfavorable years.

GRAVELLY RANGE SITE

This site consists of deep, well-drained, gently sloping, noncalcareous gravelly to very gravelly loamy soils. Permeability is moderate in these soils. Runoff is medium. Available water capacity is medium to high. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

The climax vegetation is dominantly short grasses. Midgrasses are more dominant in small areas of extra water concentration. The composition by weight of the climax vegetation, or potential plant community, is 15 percent side-oats grama; 15 percent black grama; 15 percent blue grama; 10 percent cane bluestem; 10 percent perennial three-awns; 5 percent plains bristlegrass; 5 percent plains lovegrass; 5 percent sand dropseed and sand muhly; 4 percent slim tridens and hairy tridens; 6 percent other perennial and annual grasses; 5 percent perennial forbs, including menodora, hairy tubetongue, milkwort, bladderpod, and crotons; and 5 percent woody species, including graves and gray oak, alligator juniper, javelinebush, acacias, butterflybush, winterfat, and ephedra.

Continuous heavy grazing by cattle on this site results in a decrease in blue grama, black grama, and side-oats grama and an initial increase in other species, including perennial three-awns, sand dropseed, slim tridens, and hairy grama. These species decrease as annual grass and forbs and such woody species as cacti, javelinebush, and acacias invade.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,300 pounds per acre in favorable years and 900 pounds in unfavorable years.

IGNEOUS DILL AND MOUNTAIN RANGE SITE

This site consists of very shallow to shallow, well-drained, hilly to steep, noncalcareous gravelly loamy soils. Permeability is moderate in these soils. Runoff is rapid. Available water capacity is low. The hazard of soil blowing is none to slight, and the hazard of water erosion is severe.

The climax vegetation is dominantly short and mid grasses, numerous perennial forbs, and a few woody shrubs and trees. The composition by weight of the climax vegetation, or potential plant community, is 12 percent black grama; 10 percent side-oats grama; 10 percent cane bluestem; 10 percent Texas and New Mexico bluestems; 5 percent tanglehead; 5 percent blue grama; 5 percent green sprangletop; 5 percent plains lovegrass; 3 percent spider three-awn; 10 percent such other perennial grasses as plains bristlegrass, fall witchgrass, hairy grama, sprucetop grama, slim tridens, Arizona cottontop, bottlebrush squirreltail, wolftail, and New Mexico feathergrass; 10 percent perennial forbs, including menodora, Mexican sagewort, silktop, purple daleas, bushsunflower, buckwheats, milkworts, and haplopappus; 10 percent such woody species as skeletonleaf goldeneye, feather and black dahlias, range ratany, brickellbush, and catclaw; and 5 percent oaks, alligator juniper, and pinon pine.

Continuous heavy grazing by cattle on this site results in an increase in the bluestems, side-oats grama, tanglehead, blue grama, green sprangletop, plains lovegrass, Arizona cottontop, and plains bristlegrass. Palatable forbs, including silktop and purple daleas, bush sunflower, menodora, perennial buckwheats, and Mexican sagewort, decrease under heavy use by cattle, sheep, goats, or deer. Plant species that increase under continuous heavy grazing include hairy grama, sprucetop grama, wolftail, and three-awns. Prolonged overgrazing results in further retrogression in the plant community and an increase and invasion of broom snakeweed, haplopappus, pricklepear, juniper, and catclaw.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,200 pounds per acre in favorable years and 800 pounds in unfavorable years.

SHALLOWLAND RANGE SITE

This site consists of shallow to very shallow, well-drained, gently sloping, calcareous to noncalcareous gravelly loamy and loamy soils. Permeability is moderate in these soils. Runoff is medium to rapid. Available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is moderate to severe.

The climax vegetation is short and mid grasses. The composition by weight of the climax vegetation, or potential plant community, is 25 percent black grama; 25 percent blue grama; 10 percent side-oats grama; 10 percent cane bluestem; 5 percent tobosa; 5 percent plains bristlegrass; 5 percent green sprangletop; 3 percent bull muhly, pine muhly, and purple muhly; 5 percent perennial three-awns and plains lovegrass; 5 percent such perennial forbs as bushsunflower, globemallow, bladderpod, grassland croton, and menodora; and 2 percent such woody species as graves oak, gray oak, javelinebush, feather and black daleas, and catclaw.

Continuous heavy grazing by cattle on this site results in a decrease in blue grama, black grama, side-oats grama, and cane bluestem. Tobosa, hairy grama, and three-awns initially increase under continuous heavy grazing but decrease as acacias and javelinebush invade the site.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,200 pounds per acre in favorable years and 600 pounds in unfavorable years.

Mountain Savannah vegetative zone

The Mountain Savannah vegetative zone is mostly at elevations of more than 5,000 feet.

The climax vegetation is mainly oak savannah, including gray, graves, gambels, emory, and silverleaf oaks and an increasing amount of juniper, Mexican pinyon, ponderosa pine, and Texas madrone at higher elevations. At the lower elevations there are some broad openings of grassland where there is no woody vegetation. Small areas of vegetation dominated by ponderosa pine occur at elevations of generally more than 6,500 feet; at slightly lower elevations in isolated areas of draws and canyons that have above-average moisture relationships; and on north-northwesterly slope exposures.

CANYON RANGE SITE

This site consists of deep, well-drained, rolling, noncalcareous gravelly loamy soils. Permeability is moderately rapid in these soils. Runoff is medium to rapid. Available water capacity is low. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

The climax vegetation consists of an overstory of pine, oaks, and juniper; ponderosa pine is dominant. Some woody shrubs occur in the mid-layer understory,

and the herbaceous ground layer is dominantly shade-tolerant species of bunchgrasses. The composition by weight of the climax vegetation, or potential plant community, is 40 percent ponderosa pine; 10 percent Mexican pinyon and limber pine and gray, silverleaf, and emory oaks; 22 percent mountainmahogany, netleaf foresteria, Texas madrone, chokecherry, alligator juniper, pinyon ricegrass, danthonia, and stipas; 15 percent pine and bull muhly; 5 percent Texas and New Mexico bluestems; 3 percent creeping muhly, spider three-awn, bulbo panicum, plains lovegrass, pine dropseed, and sedges; and a trace of perennial forbs and ferns.

Continuous heavy grazing by cattle, horses, or burros on this site results in a decrease in such grass species as bull muhly, Texas and New Mexico bluestems, bulbo panicum, and plains lovegrass and an increase in pine muhly, pinyon ricegrass, and oaks. Heavy browsing by deer, goats, or sheep results in a decrease in such plants as mountainmahogany, foresteria, Texas madrone, and oaks. Continuous heavy grazing may eventually reduce seedlings of ponderosa pine, Texas madrone, and oaks. Reduction in the woody overstory increases the production of herbaceous plants, especially the warm-season bunchgrasses, and decreases the production of cool-season and shade-tolerant species.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,500 pounds per acre in favorable years and 1,800 pounds in unfavorable years.

FOOTHILL SLOPE RANGE SITE

This site consists of deep, well-drained, rolling, noncalcareous gravelly loamy and loamy soils. Permeability is slow to moderate in these soils. Runoff is medium. Available water capacity is medium to high. The hazard of soil blowing is slight, and the hazard of water erosion is moderate to severe.

The climax vegetation is dominantly mid grasses, short grasses, perennial forbs, and some woody vegetation. The composition by weight of the climax vegetation, or potential plant community, is 20 percent black grama; 15 percent New Mexico bluestem; 12 percent Texas and cane bluestem; 12 percent side-oats grama; 12 percent blue grama; 5 percent green sprangletop; 5 percent Arizona cottontop; 3 percent plains lovegrass; 6 percent such other perennial grasses as woolspike balsamscale, fall witchgrass, hairy grama, Halls panicum, sprucetop grama, wolftail, spider three-awn, and Wrights three-awn; 5 percent perennial forbs, including menodora, Mexican sagewort, grassland croton, bushsunflower, hairy tubetongue, and milkwort; and 5 percent such woody species as graves, gray, and emory oak, alligator juniper, apacheplume, and cholla.

Continuous heavy grazing by cattle on this site results in a decrease in the bluestems, bull muhly, side-oats grama, green sprangletop, plains bristlegrass, plains lovegrass, and Arizona cottontop. Climax perennial forbs that decrease under continuous heavy grazing by cattle, sheep, or deer are bushsunflower, Mexican sagewort, menodora, and hairy tubetongue. Blue grama, black grama, sprucetop grama, hairy grama, wolftail, Halls panicum, and fall witchgrass increase. Prolonged overgrazing results in a plant community dominated by invading woody plants and annuals, including catclaw, cholla, pricklypear, and juniper.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,500 pounds per acre in favorable years and 1,000 pounds in unfavorable years.

IGNEOUS DIVIDE RANGE SITE

This site consists of moderately deep, well-drained, gently sloping, noncalcareous loamy soils. Permeability is slow in these soils. Runoff is slow to medium. Available

water capacity is medium. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

The climax vegetation is dominantly mid and short grasses and a few shrubs and trees. The composition by weight of the climax vegetation, or potential plant community, is 30 percent blue grama; 10 percent cane bluestem; 20 percent Texas and New Mexico bluestems and bull muhly; 8 percent side-oats grama; 4 percent spider three-awns; 5 percent wolftail and pinyon ricegrass; 3 percent other perennial grasses; 5 percent such perennial forbs as bundleflower, sagewort, snoutbean, croton, and milkwort; and 15 percent such woody species as alligator juniper, gray oak, Mexican pinyon, apacheplume, skunkbush, mountainmahogany, and butterflybush.

Continuous heavy grazing by cattle on this site results in a decrease in the bluestems, side-oats grama, bundleflower, sagewort, and snoutbean and an initial increase in blue grama, three-awns, pinon ricegrass, and wolftail. Prolonged overgrazing results in a decrease in blue grama, three-awns, and wolftail and an increase in juniper and such shade species as pinon ricegrass.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,500 pounds per acre in favorable years and 1,500 pounds in unfavorable years.

IGNEOUS HILL AND MOUNTAIN RANGE SITE

This site consists of very shallow to moderately deep, well-drained, hilly to steep, noncalcareous gravelly to cobbly loamy soils. Permeability is moderate to moderately slow in these soils. Runoff is rapid. Available water capacity is low to medium. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The climax vegetation is an oak savannah. The herbaceous vegetation is dominated by mid grasses and some tall grasses and forbs. The composition by weight of the climax vegetation, or potential plant community, is 15 percent bull muhly and pine muhly; 20 percent Texas and New Mexico bluestems; 10 percent side-oats grama; 5 percent cane bluestem; 5 percent blue grama; 5 percent spider three-awns; 3 percent woolspike balsamscale; 2 percent bottlebrush squirreltail; 15 percent other perennial grasses, including purple muhly, wolftail, hairy and sprucetop gramas, pinon ricegrass, finestem stipa, fall witchgrass, eastern gamagrass, and indiangrass; 5 percent perennial forbs, including snoutbean, Mexican sagewort, bushsunflower, sundrops, crotons, and indian paintbrush; and 15 percent woody and other species, such as graves, gray, silverleaf, and emory oak, alligator juniper, Mexican pinyon and ponderosa pine, mountainmahogany, Texas madrone, hackberry, skunkbush, hawthorn, and sacahuista.

Continuous heavy grazing by cattle on this site results in a decrease in the bluestems, side-oats grama, bull muhly, green sprangletop, plains lovegrass, eastern gamagrass, and Mexican sagewort and an increase in blue grama, hairy grama, balsamscale, purple muhly, and three-awns. Prolonged heavy use by deer results in a decrease in snoutbean, sundrop, and other perennial forbs; and heavy browsing of oaks, mountainmahogany, skunkbush, black dalea, and hackberry greatly reduces plant vigor and yields (fig. 30).

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,500 pounds per acre, including woody plant yield, in favorable years and 1,700 pounds in unfavorable years.

Figure 30.—Water pond in a narrow ravine in Mainstay-Brewster association, hilly, in Igneous Hill and Mountain range site, Mountain Savannah vegetative zone.

MOUNTAIN LOAM RANGE SITE

This site consists of shallow to moderately deep, well-drained, steep, noncalcareous cobbly to gravelly loamy soils. Permeability is moderate to moderately slow in these soils. Runoff is medium to rapid. Available water capacity is medium to low. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The climax vegetation consists of an intermittent pine oak-juniper overstory and a herbaceous understory of mid grasses and forbs. The composition by weight of the climax vegetation, or potential plant community, is 10 percent bull muhly; 10 percent Texas and New Mexico bluestem; 4 percent side-oats grama; 4 percent pine muhly and purple muhly; 6 percent pinyon ricegrass, pine dropseed, plains lovegrass, and spider three-awns; 2 percent creeping muhly; 2 percent blue grama, hairy grama, sprucetop grama, and wolftail ; 2 percent finestem stipa, littleawn needlegrass, and danthonia; 4 percent such perennial forbs as aster, astragalus, noseburn, menodora, and leafflower; 1 percent carex; 20 percent ponderosa pine; 15 percent silverleaf and gray oak; 5 percent Mexican pinyon and limber pine; 4 percent alligator juniper; 3 percent Texas madrone; 3 percent mountainmahogany; 3 percent graves, emory, and gambel oak; and 2 percent roundleaf snowberry, skunkbush, and other shrubs.

Continuous heavy grazing by cattle on this site results in a decrease in bull muhly, Texas and New Mexico bluestems, and side-oats grama and an increase in pine muhly, pinyon ricegrass, wolftail, Mexican pinyon, and juniper. Continuous heavy grazing and browsing by sheep and deer results in a decrease in perennial forbs, side-oats grama, blue grama, spider three-awns, danthonia, mountainmahogany, snowberry, oaks, and Texas madrone. Heavy grazing by all kinds of livestock and deer reduces seedlings of ponderosa pine, Texas madrone, and oaks. Such species as juniper and Mexican pinyon tend to increase under prolonged heavy grazing.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,000 pounds per acre in favorable years and 1,500 pounds in unfavorable years.

Use of the Soils for Woodland

L. K. Brink, woodland conservationist, Soil Conservation Service, helped prepare this section.

This section contains information about trees and how they are influenced by the soils on which they grow. Also described are the ways and degrees that soils affect landusers management, manipulation, and use of trees. Data are presented that should help in evaluating the soils for woodland use as well as provide information about their productivity and management.

Areas used for woodland in the county are on higher elevations of the Davis Mountains. The average precipitation is 18 to 26 inches during the frost-free period. Elevation ranges from about 6,000 feet to more than 8,000 feet. Woodland areas are those that are best able to accumulate extra quantities of water or are able to reduce the amount of water lost through evaporation and drainage.

Ponderosa pine *(Pinus ponderosa Dougl.) is* the only species of value for manufacture in conventional wood products. This tree occurs in pure stands and also in mixed stands with oaks, Mexican pinyon *(Pinus cembroides),* juniper, and other species (fig. 31). It reaches its best development on medium-textured soils along high watercourses. It occurs along more permanent streams at lower elevations as well as on north- and northeast-facing slopes of mountains.

Mexican pinyon and ponderosa pine usually grow in association with alligator juniper *(Juniperus deppeana Steud.)* and one-seeded juniper *(Juniperus monosperna Engel. Sarg.).* Also included in these stands are Mohrs shin oak *[Querous mohriana*

Figure 31.—Stockwater pond in a narrow ravine on Puerta-Madrone association, steep. Because of the well-stocked stand of pine, the area has little value for grazing.

(Buckl)], gray oak *[Querous grisea (lieubm)],* and Graves oak *[Querous gravesii (Sudw)],* big tooth maple *(Acer grandidentatum Nutt),* and Mexican ash *(Fraxinum berlandierana A. DC).*

Associated understory vegetation varies by site quality and timber type. Included are woody shrubs; snowberry, skunkbush, elbowbush, madrone, fern, mountainmahogany, chokeberry, and grasses; and side-oats grama, blue grama, Texas bluestem, long-awn muhly, pine muhly, bull muhly, New Mexico bluestem, and green sprangletop.

Ponderosa pine is occasionally logged for lumber and poles, and Mexican pinyon is utilized mainly as a Christmas tree. Juniper is mainly used locally for fenceposts. Oak is utilized to a limited extent as firewood. The major uses of woodlands are grazing and hunting.

Those soils that are suitable for woodland are rated for production and management. The purpose is to provide currently available knowledge about the soils as they relate to the establishment, growth, management, and harvest of wood crops.

Field information was gathered during the course of the survey. Information obtained from soil and tree studies was recorded by soils. The interpretations presented herein are from this data.

Table 2 includes some evaluations of soils that are suitable for woodland use. Ponderosa pine is the only commercially important tree species adapted to soils in Jeff Davis County.

The potential productivity is expressed as average site index for ponderosa pine. The site index curve used is based on growth height in feet for 100 years. Eighty-six feet or more is rated *very high;* 76 to 85 feet, *high;* 66 to 75 feet, *moderate;* 56 to 65 feet, *moderately low;* and less than 55 feet, *low.*

The hazard of water erosion, equipment restrictions, and seedling mortality are concerns of management. The potential erosion hazard of the soil in woodland use was evaluated after cutting operations or where the soil is exposed along roads, trails, firebreaks, or log-yarding areas. A rating of *slight* indicates that erosion control is unimportant. A rating of *moderate* indicates some attention must be given to prevent unnecessary soil erosion. A rating of *severe* indicates that intensive treatment or special equipment and methods of operation are needed to minimize soil erosion. The potential erosion hazard is based on slope, soil depth, erodibility, and soil loss tolerance.

The ratings for equipment restrictions reflect limitations in the use of equipment for managing or harvesting the tree crop. A rating of *slight* indicates equipment use is seldom limited in kind or in time of year. A rating of *moderate* indicates a need for modified equipment or seasonal restrictions caused by slope, stones, obstructions, soil wetness, flooding, or overflow. A rating of *severe* indicates the need for specialized equipment because of one or more of the factors listed above.

Seedling mortality refers to the expected degree of mortality during the first two growing seasons after planting or seeding. Normal rainfall, adequate site preparation, good planting stock, proper planting methods, and appropriate protection and cultivation are assumed. A rating of *slight* indicates that unsatisfactory survival on less than 25 percent of the area is likely. A rating of *moderate* indicates that unsatisfactory survival is likely on 25 to 50 percent of the area planted. A rating of *severe* indicates that unsatisfactory survival is likely on more than 50 percent of the area.

A woodland suitability group is made up of kinds of soil that are capable of producing similar kinds of wood crops, that need similar management to produce these crops, and that have about the same potential productivity. The ordination system and the suitability group symbols are explained in the following paragraphs.

The first element of the group symbol indicates the woodland suitability class. It expresses site quality by an Arabic numeral that ranges from 1 to 5. Class 1 is the

highest quality, and class 5 is the lowest. Only classes 2, 3, and 5 are in Jeff Davis County.

The second element in the symbol indicates the suitability subclass. Only suitability subclass *x* is in Jeff Davis County. This subclass expresses the stoniness of the soils that causes a moderate to severe hazard or limitation in woodland use or management.

The third element in the symbol indicates the degree of hazard or limitation and the general suitability of the soils for certain kinds of trees. The three management problems considered are the hazard of water erosion, equipment restrictions, and seedling mortality. The numeral 2 indicates soils that have one or more moderate management problems and are better suited to needleleaf trees than others. The numeral 3 indicates soils that have one or more severe management problems and are better suited to needleleaf trees than others.

Use of the Soils for Wildlife Habitat

By James Henson, biologist, Soil Conservation Service.

The wildlife of Jeff Davis County is varied because of the great variations in habitat. Wildlife is characteristic of the desert and mountains of the southwest. Native big game species are the desert mule deer, white-tailed deer, javelina, and antelope. They are hunted commercially and are of economic importance to the county. A few species of exotic game animals have been successfully introduced, mainly mouflon and Barbados sheep. Also, a few buffalo are in the county (fig. 32).

Among the native carnivorous group are the panther, bobcat, coyote, raccoon, ringtail, desert fox, gray fox, and badger. Four species of skunk inhabit this region. Porcupine, black-tailed jack rabbit, and the Davis Mountain cottontail are also found in the county, as are rock squirrel, Mexican squirrel, and spotted ground squirrel. Several species of pocket gophers dwell in this region. The black-tailed prairie dog and black bear have been exterminated in the county.

Figure 32.—Buffalo grazing on Musquiz association.

Important game birds are scaled quail, mourning dove, and various species of duck. There are lesser populations of Gambel's quail, Mearns quail, and whitewing doves. Wild turkey have been stocked in selected areas. Band-tailed pigeons occur in limited numbers and appear to be increasing at the higher elevations of the Davis Mountains. Many species of songbirds make their homes here; others migrate in seasonally.

Fishing waters are limited to small ponds that have been stocked with black bass, channel catfish, and sunfish. Raindow trout have been stocked in spring-fed ponds and stock ponds at higher elevations that are cold enough for them.

Successful management of wildlife on any tract of land requires that adequate food, cover, and water be available. Lack of any of these necessities or an unfavorable balance between them severely limits desired wildlife species or accounts for their absence. Information about soils is a valuable tool in creating, improving, or maintaining suitable food, cover, and water for wildlife.

Most wildlife habitat is managed by planting suitable vegetation, by manipulating the existing vegetation so as to bring about natural establishment or an increase or improvement in desired plants, or by combinations of such measures. The influence of a soil on the growth of plants is known for many kinds and can be inferred for others from a knowledge about the characteristics and behavior of the soil. In addition, water areas can be created or natural ones improved as wildlife habitat. Information about soils is useful for these purposes.

The soil interpretations for wildlife habitat in table 3 can serve a variety of purposes. They aid in selecting the more suitable sites for various kinds of management. They serve as indicators of the level of management intensity needed to achieve satisfactory results. They also serve as a means of showing why it may not be feasible generally to manage a particular area for a given kind of wildlife. These interpretations also may serve in broad-scale planning of wildlife management areas, parks, and nature areas or for acquiring wildlife lands.

The soil areas shown on the soil survey maps are rated without regard to positional relationships with adjoining mapped areas. The size, shape, and location of the outlined area do not affect the rating. Certain influences on habitat, such as elevation and aspect, must be appraised at the site.

In table 3 the soils of Jeff Davis County are rated for the creation, improvement, or maintenance of four elements of wildlife habitat. The ratings are based upon limitations imposed by the characteristics or behavior of the soil. Four levels of suitability are recognized. Adjective ratings of *good, fair, poor,* and *very poor* indicate the degree of soil suitability for a given habitat element.

The four habitat elements rated in table 3 are defined and exemplified as follows:

GRAIN AND SEED CROPS.—These are farm grain or seed-producing annuals planted to produce food for wildlife. Examples are corn, sorghum, millet, wheat, oats, and sunflower.

GRASSES AND LEGUMES.—These are domestic perennial grasses and legumes that are established by planting and furnish food and cover for wildlife. Examples are ryegrass, fescue, panicumgrasses, and johnsongrass. Legumes include such species as clovers and alfalfa.

WILD HERBACEOUS UPLAND PLANTS.—These are perennial grasses, forbs, and weeds that provide food and cover for wildlife. Examples are crotons, wild bean, indiangrass, wild ryegrasses, and bluestems.

SHRUBS AND TREES.—These are trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, or foliage (browse) used extensively as food by wildlife. These plants commonly become established through natural processes, but they may be planted. Examples are oak, mesquite, whitebrush, Mexican pinyon, catclaw acacia, wild cherry, grape, juniper, greenbrier, and wild rose.

The two general kinds of wildlife covered in the table are:

OPEN LAND WILDLIFE.—Open land wildlife consists of birds and mammals that normally frequent cropland, pasture, and areas that are overgrown with grasses, herbs, and shrubby growth. Examples of this kind of wildlife are quail, jackrabbits, meadow larks, and lark sparrows.

RANGE WILDLIFE.—Range wildlife consists of birds and mammals that normally frequent wooded areas of hardwood trees and shrubs. Examples of range wildlife are deer, turkey, squirrel, raccoon, and javelina.

Habitat suitability ratings used in table 3 are defined as follows. A rating of *good* indicates that habitat generally is easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected. A rating of *fair* indicates that habitat can be created, improved, or maintained in most places; that the soil has moderate limitations that affect management; and that moderate intensity of management and fairly frequent attention may be required for satisfactory results. A rating of *poor* indicates that habitat can be created, improved, or maintained in most places; that the soil has rather severe limitations; that habitat management is difficult and expensive and requires intensive effort; and that results are not always satisfactory. A rating of *very poor* indicates that the soil limitations are so extreme that it is impractical, if not impossible, to manage the designated habitat element. Unsatisfactory results are probable. (For short-term usage, soils rated "very poor" may provide easy establishment and temporary value.)

Engineering Uses of the Soils

By Nelton O. Salch, area engineer, Soil Conservation Service.

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4, 5, and 6, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those in tables 4 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many mapped areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering. Specific values should not be assigned to the estimates for traffic-supporting capacity in this survey.

Some of the terms used in this soil survey have special meaning to soil scientists that is not known to all engineers. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system *(12)* used by the Soil Conservation Service, Department of Defense, and other agencies and the AASHTO system *(1)* adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM. and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CH-MH. Soils classified represent that part of the soil that is finer than the 3-inch (76-millimeter) sieve.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups that range from A-1 to A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b; A-2-4, A-2-5, A-2-6, A-2 7; and A-7-5 and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification, without group index numbers, is shown in table 4 for all soils mapped in the survey area.

Estimated soil properties significant in engineering

Table 4 provides estimates of soil properties important to engineering. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and detailed experience in working with the individual kind of soil in the survey area.

Hydrologic soil groups are used in watershed planning to estimate runoff from rainfall. Soil properties are considered that influence the minimum rate of infiltration obtained for a bare soil *after prolonged wetting.* These properties are: depth of seasonally high water table, intake rate and permeability after prolonged wetting, and depth to very slowly permeable layer. The influence of ground cover is treated

independently, not in hydrologic soil groups. The soils have been classified into four groups, A to D.

GROUP A (low runoff potential).—Soils that have high infiltration rates even when thoroughly wetted and consist chiefly of deep, well-drained to excessively drained sand or gravel. These soils have a high rate of water transmission.

GROUP B (moderately low runoff potential).—Soils that have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well drained to well drained soils that are moderately fine textured to moderately coarse textured. These soils have a moderate rate of water transmission.

GROUP C (moderately high runoff potential).—Soils that have slow infiltration rates when thoroughly wetted and consist chiefly of soils that have a layer that impedes the downward movement of water, are moderately fine textured to fine textured, or have a moderately high water table. Some of these soils are somewhat poorly drained.

GROUP D (high runoff potential).—Soils that have very slow infiltration rates when thoroughly wetted and consist chiefly of clay soils that have a high shrink-swell potential, have a permanent high water table, have a claypan or clay layer at or near the surface, and are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to bedrock is the depth at which solid rock underlies the soils. Salinity does not present a serious problem in Jeff Davis County and is not included in table 4. The water table is many feet below the soil surface, and this column is not included on the table.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

Permeability, as used in table 4, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties that result from use of the soils are not considered.

Available water capacity is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at the wilting point. It is commonly expressed as inches of water per inch of soil. It should not be confused with coefficient of permeability "k" used by engineers.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with material that has this rating.

Engineering interpretations

The estimated interpretations in table 5 are based on the engineering properties of soils shown in table 4, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Jeff Davis County. Although the information applies only to the soil depths indicated in the table, it is reasonably reliable to depths of about 6 feet for most soils and several more for some. In table 5, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of crops and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions.

For these particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use or, in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special design. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, that is used as a top dressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use.

Sand and gravel ratings are based on the probability that mapped areas of the soil contain deposits of sand and gravel. The ratings do not indicate quality or size of the deposits.

Road fill is material used to build embankments. The ratings indicate performance of soil material moved from borrow areas for these purposes.

Corrosivity, as used here, indicates the potential danger to uncoated metal through chemical action that dissolves or weakens the structural material. Structural material may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than installations made entirely in one kind of soil or soil horizon.

Corrosivity to concrete structures caused by soil properties in the county is low. No special precautions are necessary for concrete structures in Jeff Davis County to prevent chemical action that dissolves or weakens the structural material.

Terraces and diversions are channels that have supporting ridges on the lower side across the slope to divert water. The soil features are those that influence stability and affect use of the soil as construction material.

Irrigation suitability depends largely on the rate of water intake, available water capacity, depth of soil, slope of land, susceptibility to water erosion and soil blowing, and flood hazard.

Local roads and streets are influenced by features of the undisturbed soil that affect construction and maintenance of roads and streets. The soil features considered, favorable as well as unfavorable, are the principal ones that affect the geographic location of roads and streets.

Farm pond reservoir areas are affected mainly by seepage loss of water, and the soil features considered are those that influence such seepage.

Farm pond embankments serve as dams. The soil features of both subsoil and substratum are those important to the use of soils for embankments.

Dwellings are affected by features of the undisturbed soil that is used to support foundation footings of houses or other low buildings no higher than three stories. Footings are assumed to be 1 foot wide and a minimum depth of 1 foot. The properties that affect the foundation support are those that affect bearing capacity and settlement under load and those that affect excavation and cost of construction. Specific values of bearing strength are not assigned.

Septic tank filter fields are affected mainly by permeability, location of water table, and susceptibility to flooding. The degree of limitation and the principal reasons for assigning moderate or severe limitation are given.

Sewage lagoons are influenced chiefly by such soil features as permeability, location of the water table, and slope. The degree of limitation and the principal reasons for assigning moderate or severe limitations are shown.

Light industry is affected by properties of the undisturbed soil that is used to support foundations for light industrial buildings. Emphasis is on foundations, the ease of excavation for underground utilities, and the corrosion potential of uncoated steel pipe. The undisturbed soil is rated for spread footing foundations for buildings less than three stories high or foundation loads not in excess of that weight.

Sanitary landfill is a dug trench in which refuse is buried. The refuse is covered with at least a 6-inch layer of compacted soil daily, or more frequently if necessary. Soil material excavated in digging the trench is used for this purpose. A final cover of soil material at least 2 feet thick is placed on the landfill when the trench is full. There is a need for geological investigation of the area to determine the potential for pollution of ground water as well as to obtain the design of the sanitary landfill, because many operations use trenches as deep as 15 feet or more. Soil features that influence ratings are soil drainage, permeability, texture, slope, hazard of flooding, and depth to bedrock or seasonal high water table.

Shallow excavations are those that require excavating to a depth of 6 feet or less. Such uses include underground utility lines (pipelines, sewers, cables), cemeteries, basements, and open ditches, although some supplemental criteria may be needed for pipelines and cemeteries. Desirable soil qualities and characteristics are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops and big stones, and freedom from flooding.

Engineering test data

Table 6 contains the results of engineering tests performed by the Texas Highway Department on some of the major soil series in Jeff Davis County. These tests were made to help evaluate the soils for engineering purposes. The samples were taken in representative sites. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering. The engineering classifications shown are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by the combined sieve and hydrometer method.

Shrinkage limit is the maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass. Because clay is the major soil fraction that causes shrinkage, the shrinkage limit of a soil is a general index of clay content and, in general, decreases with increases in clay content.

Shrinkage ratio is a given volume change, expressed as a percentage of the dry volume, to the corresponding change in water content above the shrinkage limit, expressed as a percentage of the weight of the oven-dried soil.

Lineal shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit. It is used to give some indication of the amount of cracking that takes place in a soil as a result of drying.

Mechanical analyses show the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and other coarser materials do not pass through the No. 200 sieve. Silt and clay pass through the No. 200 sieve. Silt is that material larger than 0.002 millimeter in diameter that passes the No. 200 sieve, and clay is that fraction passing the No. 200 sieve that is smaller than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than by the pipette method used by most soil scientists in determining the clay in soil samples.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from

a dry state, the material changes from a solid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

The AASHTO and Unified classifications have been explained earlier in the engineering section.

Use of the Soils for Recreation

By Hubert B. Jaco, soil scientist, Soil Conservation Service.

Outdoor recreational activities are increasing in Jeff Davis County. A State Park and a National Historical Site are in the county. Several camp areas, picnic areas, and other outdoor recreation areas have been developed on privately owned ranches.

Table 7 contains information useful to engineers, contractors, and others who use existing land resources for planning recreation areas. The ratings and other interpretations in this table are based on estimated engineering properties of the soils in table 4, on available test data, and on field experience.

The limitations are rated slight, moderate, or severe. *A slight* rating indicates that soils have properties favorable for the rated use. Limitations are so minor that they can be easily overcome. Good performance and low maintenance can be expected from these soils. *A moderate* rating indicates that soils have properties moderately favorable for the rated use. Limitations can be overcome or modified with planning, design, or special maintenance. Some of these limitations can be tolerated. *A severe* rating indicates that soils have one or more properties unfavorable for the rated use. Limitations are difficult and costly to modify or overcome, requiring major soil reclamation, special design, or intense maintenance. Some of these limitations can be tolerated.

Camp areas are those areas to be used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little site preparation is normally required other than shaping and leveling for tent and parking areas. These areas are subject to heavy foot traffic and limited vehicular traffic. The assumption is made that good vegetative cover can be established and maintained.

The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry.

Picnic areas (fig. 33) are for park-type picnic areas. These areas are subject to heavy traffic, but most vehicular traffic is confined to access roads. Preparation of an area consists of leveling sites for tables and fireplaces and building access roads. The assumption is made that good vegetative cover can be established and maintained. Soil limitations for waste disposal and for playgrounds are treated as separate items.

Important soil properties that affect this use are wetness, flooding, slope, surface texture, and rockiness. A prime requirement for this use is freedom from muddiness and dustiness. Strong slopes and rockiness greatly increase the cost of site leveling and building access roads.

Playgrounds are those areas that are intensively used for play, such as baseball, football, badminton, and other organized games. These areas are subject to intensive foot traffic. The assumption is made that good vegetative cover can be established and maintained.

Figure 33.—In the foreground among the large boulders is a picnic area at roadside park on Hurds-Friends association, rolling. The area affords a scenic view of Sawtooth Mountain, in the background.

Soil properties that affect the use of the soil for playgrounds are those that affect intensive foot traffic and those that affect design, construction, and maintenance. The best soils for playgrounds have a nearly level surface free of coarse fragments and rock outcrops, good water drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry. Depth to rock is an important consideration on uneven slopes that require grading and leveling.

Paths and trails applies to the use of soils for local and cross-country foot paths and trails and for bridle paths. It is assumed that the soils would be used in their natural state and that little or no cutting and filling would be done in design and layout of the trails.

Soil properties that affect paths and trails are those that affect foot traffic, such as wetness, surface texture, and coarse fragments; and those that affect design, construction, and maintenance, such as slope, rockiness, or stoniness. Safety features, such as sheer cliffs and slippery rocks, were not considered in table 7 but may be important items to consider in final evaluation of a site.

For interpretations of the limitations and soil features affecting roads and streets, septic tank filter fields, sewage lagoons, sanitary landfills, and corrosivity of uncoated steel, refer to table 5.

Formation and Classification of the Soils

In this section the factors of soil formation are described as they relate to the soils of Jeff Davis County. The processes of soil horizon differentiation are explained, and the classification of the soils is given.

Factors of Soil Formation

Soils are formed through the interaction of climate, living organisms, parent material, relief, and time. The nature of a soil depends on the combination of these five factors. Each of the factors comes into play in the formation of every soil, but the

relative importance of each differs from place to place. In some places one is dominant, and in other places, another. It is the best interaction of the five factors that is of first importance in determining the present nature of every soil.

Climate

The climate of the past geologic ages has influenced the deposition of parent material and the carving of the landscape. The recent climate, including rainfall, temperature, humidity, evaporation, and wind, has been important in the formation of soils in Jeff Davis County.

Climate, rainfall, and temperature are variable in the county because of variations in elevations, which range from about 3,200 feet to more than 8,000 feet. Generally, rainfall increases with altitude, whereas temperature decreases. Rainfall average is about 2 inches higher and the temperature average is about 3 degrees F lower for each 1,000-foot increase in altitude. Soils at the lower elevations are calcareous, because not enough water has passed through them to leach out the lime. They are also low in organic-matter content because of low rainfall and high temperature, and they support only a small amount of vegetation. Soils at higher elevations are neutral to acid, because enough water has passed through them to leach the lime. They are also higher in organic-matter content because of higher rainfall and lower temperature, and they support a greater amount of vegetation.

Living organisms

Vegetation, microorganisms, earthworms, and other forms of life that live on and in the soil contribute to its formation. The types and amounts of vegetation are important. They are determined partly by climate and partly by the kind of parent material.

In arid and semiarid areas that support little vegetation, the soils are low in organic-matter content and are light colored. Examples are Anthony, Canutio, Nickel, Reagan, and Vieja soils. In arid and semiarid areas that support a cover of grass, the soils are higher in organic-matter content and are dark colored. Such soils are high in humus and in many places have a surface organic layer. Examples are Loghouse, Madrone, and Puerta soils.

Overflow areas of valleys generally have the more vegetative growth, such as low shrubs and various native grasses. Soils of overflow areas are Reagan, Hodgins, Sanderson, Upton, Dalby, and Verhalen soils.

Microorganisms have played an important part in soil formation. They help in improving soil structure by breaking down organic matter. The light-colored soils do not have as many microorganisms as the dark-colored soils.

Worms, rodents, and other burrowing insects and animals have also affected soil formation. They mix the soil, aerate it, and provide channels that permit the penetration of water.

Parent material

Soils of Jeff Davis County have a wide range of parent material. It consists of material produced by weathering of consolidated rocks of hills and mountains. The source of sediments, as well as the types of rocks, influence texture and the chemical and mineralogical composition of the soils.

About 50 percent of the land area of Jeff Davis County consists of stony soils that rest directly on rock. These rocks are of igneous, sedimentary, and metamorphic formations *(5, 8).*

Igneous rocks of the Tertiary age, caused by many volcanic activities, make up the bulk of surface rocks. These are mainly igneous extrusive rock. Only a few small areas of igneous intrusive rocks are exposed. The extrusive rock types are rhyolite, andesite, latite, trachyte, basalt, and tuff. Intrusive rocks, which occur as sills, small

stocks, and dikes, are quartz microsyenite, quartz trachyte, latite, chlorite latite, and trachyandesite *(2, 3).*

These igneous rocks are low in carbonates. They are classed as alkalic, because the ratio of sodium and potassium to silica or aluminum is high enough to permit formation of alkalic minerals. There is a high ratio of sodium and potassium to calcium. The alkali nature of the igneous rocks probably accounts for the high translocation of clay in most soils that formed in material weathered from these rocks.

Soils that formed in material weathered from igneous rocks are Brewster, Kokernot, Liv, Madrone, Mainstay, Puerta, Sproul, and Volco soils.

Sedimentary rocks are mainly of the Cretaceous age. The rock types are limestone, marl, sandstone, and shale. These rocks are high in calcium carbonates. Soils that are in material weathered from these rocks are calcareous. These soils are in the Ector, Lozier, and Vieja series.

Metamorphic rock outcrop covers something less than 1 square mile in H. 0. Canyon, south of Sawtooth Mountain. The rock types are marble and quartzite. Both rock types are very resistant to weathering, thus having little influence on soils.

After the carving of valleys, material is washed and blown from uplands and redeposited. These unconsolidated sediments are of recent to Pleistocene age *(4, 6, 7)*. The source and type of these deposits determine the soils that form. These are such soils as Anthony, Glendale, Gageby, Ima, Hodgins, Redona, and Verhalen soils.

Relief

This county is characterized by hills and mountains separated by valleys. The influence of topography on soil formation is pronounced. The normal geologic erosion is far greater on steep surfaces than on level ones. As a result, the soils of hills and mountains are shallow, whereas the soils of valleys and plains are deep.

Soils on steep, north-facing surfaces of mountains produce more vegetation than soils on south-facing surfaces. Soils on level areas are generally more productive than those on sloping areas.

Soils that formed in alluvium of valleys have a deeper A horizon on level areas than on sloping areas. Generally, soils on sloping areas contain more gravel than those on level areas.

Slope is important in the relation to soil moisture condition and profile development.

Time

Many characteristics of a soil are determined by the length of time the soil-forming factors have acted upon the parent material. Some material has been in place only a short time and has not been influenced by climate or living organisms to develop genetically related horizons. Other material has been in place a long time and has undergone major soil-forming processes, developing genetically related horizons.

Deposits in the county are of four distinct ages. They are divided into old deposits, being gravelly or stony alluvium that has layers high in clay accumulation or well cemented with caliche and forms such soils as Boracho, Friends, Limpia, and Madrone soils; intermediate deposits, being gravelly and fine-grained sediments that have distinct zones of clay or lime accumulation and form such soils as Chispa, Hurds, Musquiz, and Reagan soils; young deposits, being sediments of fine and gravelly alluvium that has slight alterations and forms such soils as Canutio, Hodgins, Medley, and Sanderson soils ; and recent deposits that have little or no alteration and form such soils as Anthony, Gageby, and Rockhouse soils.

Processes of Horizon Differentiation

The differentiation of soil horizons in Jeff Davis County is the result of several processes. Among these are accumulation of organic matter; eluviation of calcium carbonates, clays, humus, and other minerals; illuviation of calcium carbonates, clays, and other minerals; cementation by calcium carbonates and silica; and formation of clay minerals. In most soils more than one of these processes has been active in the development of horizons.

The accumulation of organic matter on the surface has been important in the formation of an O horizon. Generally, soils of the woodlands have a large amount of litter and partly decomposed organic material on the surface. The main soils that have an organic horizon are Loghouse and Madrone soils.

The accumulation of organic matter in the surface layer of soils has been important in the formation of an A1 horizon. Soils that formed under a good cover of grass have a dark-colored A1 horizon that is high in organic-matter content. Examples of these soils are Gageby, Musquiz, and Brewster soils. Soils that formed under a thin cover of grass or shrubs have a light-colored A1 horizon that is low in organic-matter content. Examples of these soils are Canutio, Anthony, and Vieja soils.

Eluviation, or the washing out of bases, humus, and clays, has been important in the formation of an A2 horizon in some soils. The A2 horizon is a light-colored, acid soil layer near the surface that loses certain constituents by leaching. Soils that have an A2 horizon are Friends, Loghouse, Madrone, and Puerta soils.

Illuviation, or the washing in of clays, has been important in the formation of a B2t horizon. This layer has clay films and contains more clay than the surface layer. Some of the soils in Jeff Davis County that have a B2t horizon are Liv, Mainstay, Musquiz, and Puerta soils. In some soils the translocation of minerals, mainly bases, has been important in the formation of a colored B horizon. Some of the soils that have this type of B2 horizon are Espy, Hodgins, Reagan, and Sanderson soils. In other soils the formation of clay minerals, mainly in place, has been important in the formation of a B2 horizon.

Illuviation of calcium carbonates has been important in some soils in the formation of a calcic horizon. The carbonates can accumulate in any horizon but mainly in the B or C horizon. They are indicated by the attachment of the symbol *ca,* as in Bca or Cca. Some of the soils that have a calcic horizon are Chispa, Nickel, Redona, and Reagan soils.

Cementation by calcium carbonates and silica has been important in the formation of an indurated caliche or strongly caliche horizon in some of the soils. This type of horizon is indicated by the attachment of the symbol *cam* to the horizon designation, as in Ccam. Some of the soils that have this type of horizon are Boracho, Espy, Mitre, and Upton soils.

The C horizon has been changed little, because disposition occurs at the base of the A or the B horizon. The top part of the C horizon accumulates calcium carbonates, which are translocated from the above horizons.

The symbol R is used to indicate bedrock formation at the base of some soils. Brewster and Ector soils are examples of soils that are shallow to bedrock.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in

successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 and revised later. The system currently used by the National Cooperative Soil Survey was developed in the early sixties and was adopted in 1965 *(11).* It is under continual study *(9).*

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis, or mode of origin, are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 8 shows the classification of each soil series of Jeff Davis County by family, subgroup, and order, according to the current system.

ORDER.—Table 8 shows that the five soil orders in Jeff Davis County are Entisols, Vertisols, Aridisols, Mollisols, and Alfisols.

Entisols are recent soils that do not have genetic horizons or that have only the beginning of such horizons. Some of the soils in this order were formerly called Lithosols and Alluvial soils.

Vertisols are soils in which natural churning or inversion of soil material takes place, mainly through the swelling and shrinking of clays. Soils in this order were formerly called Grumusols.

Aridisols are soils that formed in a dry climate and have a light-colored A horizon.

Mollisols are soils that have high base supply and a dark-colored A horizon that is friable or soft and has a high content of organic matter.

Alfisols are soils that have a clay-enriched B horizon that is high in base saturation.

SUBORDER.—Each order is divided into suborders, mainly on the basis of those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the order. Soil properties used to separate suborders mainly reflect soil differences that result from the climate or vegetation.

GREAT GROUP.—Suborders are separated into great groups on the basis of uniformity in kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that have pans that interfere with the growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, subgroup, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives in front of the name of the great group.

FAMILY.—Families are established within a subgroup mainly on the basis of properties important to the growth of plants or behavior of the soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and arrangement

in the profile. New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program. Most of the soil series described in this publication have not been established earlier.

Additional Facts About the County

The area was opened in 1854 by the establishment of Fort Davis at the crossroads of the Chihuahua Trail and the Butterfield Overland Mail Route. Orders for establishment came from Jefferson Davis, then secretary of war. The fort was named in his honor. The completion of the railroads opened the area for ranching.

In 1887 Jeff Davis County was formed from a part of Presidio County. It was named in honor of Jefferson Davis, the president of the Confederacy.

Fort Davis and Valentine are the only towns in the county. The county seat is Fort Davis, which sprang up as a service center for the fort. Valentine is a railroad town that was established as a railroad terminal.

Climate

By Robert B. Orton, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

With an average elevation of 1 mile or higher, Jeff Davis County is higher above sea level than any county in Texas. Several peaks rise above 7,000 feet and Mount Livermore, the highest, reaches 8,382 feet. Being mountainous, Jeff Davis County has a mountain-type climate. More specifically, it may be described as a cool-temperate climate with warm summers. Variations in elevation affect the weather and climate of an area, and thus no single location or even a selection of several locations adequately describes the climate of the entire county. Generally, precipitation increases as altitude increases, particularly on the windward slopes; and temperature decreases with altitude. Temperature averages about 1° F lower for each 300 feet of increased altitude.

Rainfall records show that, in an average year, Mount Locke (elevation 6,790 feet) receives approximately 4 inches more rainfall than Fort Davis (elevation 4,800 feet). Comparable records are not available from the western part of Jeff Davis County, but isohyetal charts of the Trans Pecos Region indicate that average annual rainfall in this part of the county west of the higher ridges is about 12 inches. Two-thirds of the average annual precipitation falls during the 5-month period of May to September.

Winter storms, moving across from the Pacific, deposit snow in the area, but often the snowfall is light and soon melts from exposure to the sun's radiation. The average monthly snowfall data are biased by rare, exceptionally heavy snows so that the statistic is a poor estimate of expected snowfall.

Jeff Davis County is partly protected from the cold air masses that move southward across the plains in winter. Many of these turn southeastward before reaching the area. Surges of cold air from the mountain States bring rapid drops in daytime temperatures from late in fall to early in spring, but these cold spells are of rather short duration, rarely lasting more than 36 to 48 hours.

Temperature data in the accompanying table are from Alpine, located in neighboring Brewster County, about 22 miles southeast of Fort Davis. For the county as a whole, these data were considered more representative than Mount Locke data—the only temperature data available from Jeff Davis County. The combination of low relative humidity and high elevation results in a very pleasant summer climate in Jeff Davis County. While daytime temperatures may occasionally be higher than 100° F, the average daily maxima are in the upper 80's throughout most of the county. Radiational cooling after sundown lowers the temperature rapidly.

Relative humidity measured at noon, Central Standard Time, averages about 44 percent in January, 33 percent in April, 39 percent in July, and 40 percent in October. It also varies with elevation and with the time of day. Sunshine is abundant, averaging about 70 percent of the total possible in winter, 78 percent in spring, 79 percent in summer, and 75 percent in the fall. Evaporation exceeds precipitation by about 52 inches in an average year. At elevations between 4,000 and 5,000 feet, the average growing season (freeze-free period) is estimated to be 215 to 230 days. Table 9 summarizes data for the county.

The prevailing wind is southerly to southwesterly from about October to April and southeasterly from May to September.

Farming

Jeff Davis County is mostly a cattle county. On ranches, Hereford cattle predominate. The cow-calf is the main type of cattle operation, but a few ranches also run steers. Most of the ranchers' income comes from the sale of calves in fall. Other income on ranches is derived from sheep, goats, horses, and hunting leases.

Rainfall is the major limiting factor in yearly forage production on range. Rainfall is variable, resulting in large seasonal variation of forage. Drought is common, and it is difficult at times to make changes in the number of grazing animals to prevent overuse of range plants.

Growth of vegetation is greatest in summer, which is the season of highest rainfall. Very little forage is made in winter and spring, which are the dry months. Stockmen can appraise their forage supply in fall and make adjustments in livestock numbers so as to be able to carry their stock through to the next summer.

The main objective of good range management is to keep the range in good condition. If this is done, water is conserved, yields are increased, and the soils are protected. The success of the rancher depends on how successfully he keeps soils productive with good forage plants.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Badlands. Areas of rough, irregular land where most of the surface is occupied by ridges, gullies, and deep channels. Land hard to traverse.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Concretions. Grains, pellets, or nodules of various sizes, shapes and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard and brittle; little affected by moistening.

Decreaser. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.
Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.
Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.
Well-drained soils are nearly free from mottling and are commonly of intermediate texture.
Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.
Somewhat poorly drained soils are wet for significant periods but rot all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.
Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.
Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle, subsurface horizon that is very low in organic-matter content and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Increasers. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increasers commonly are shorter than decreasers, and some are less palatable to livestock.

Invaders. On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface. (Most weeds are "invaders".)

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few*, *common,* and *many;* size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil series or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair*, and *poor.* The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline

soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Site index. A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal

forms of soil structure *are—platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain, (each* grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements found in soils in extremely small amounts, yet which are essential to plant growth. Some of the trace elements are zinc, cobalt, manganese, copper, and iron.

Variant, soil. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

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